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Moreton Bay Fig Wasps in Hawaii.

Mr. Osborn gathered some figs from the Moreton Bay fig tree in Emma Square on June 22nd, and found that they contained fig wasps *(Pleistodonta froggatti)*. Ten days later a large crop of ripe fruit fell from this tree. which was appreciated by the Mynah birds and small boys. Since then the wasp has been found to be established on the Moreton Bay fig up Nuuanu.

The wasp was received from Mr. Pemberton on February 9th, and liberated on the 9th and 10th of February. It is evidently the second, or even the third, generation in Honolulu. We can therefore consider that it is established and, unless something unforeseen happens, will continue to thrive and fertilize the Moreton Bay figs.

The difference between the ripe and unfertilized figs is very evident on account of their size, shape, and color. The caretaker at Emma Square noticed the difference, and stated that the ripe figs were being gathered to make pies of. It is feared they would make very seedy pies.

This is the first case on record where the fig wasp of a wild fig tree has been established outside of its natural habitat, and demonstrates the necessity of the presence of the wasp for the production of seeds in the fig.

There is an important point still not settled in the relationship of the wasp to the fig. Is it simply the pollenization that causes the young fig not to fall and to continue to develop, or is it some stimulus caused by the presence of the wasp or the action of egg laying? Now that we have fertile pollen we may be able to settle the question. F. M.

Selection of Superior Strains in Plant Improvement.

Additional evidence that agricultural crops can be improved through finding, isolating, and propagating superior individual plants is offered by articles bearing on the improvement of yields of potatoes and rubber, reprinted in this issue from other journals.

The selection methods seek specimens or strains that are definitely better than the average run, and that have, furthermore, the prepotency to transmit to their progeny this inherent superiority.

The Fern Weevil in Australia.

F. Muir.

A consignment of the fern weevil parasite, a species of *Ischiogonus*, arrived by the S.S. Makura on May 21, and several adults came through in good condition. Some of them have been liberated on Tantalus and others kept for breeding in captivity. It will take several months before we shall have any knowledge of their establishment in the Territory.

The following extract from a letter from Mr. Pemberton, dated Lismore, Richmond River, New South Wales, April 30, 1921, gives some interesting details of the condition of the fern weevil and its parasites in its natural habitat.

"I have spent the past twelve days on the Richmond River in northern New South Wales, searching in the forests at the source of some of its tributaries for the fern weevil *Syagrius fulvitarsis*. I have found the weevil, have bred a parasite from its larva, and am now bound for Sydney with about fifty individuals of the parasite in the egg, larval and pupal stages. I will place these on the S.S. Makura, in charge of the captain, and will put some in the cool chamber or vegetable room. It will be many days before they reach Honolulu, but the chance of some surviving must be taken. Perhaps some of the adults will not be ready to emerge before reaching Honolulu.

"When I reached Lismore, on the Richmond River, I found no forests or uncut scrub left, but some twenty miles up its tributaries I came to magnificent, virgin forests, containing an abundance of ferns. I soon found the weevil, though it is comparatively rare. I found it in dense, untouched forests, deep in their interior. I am convinced that it is native here and not introduced, though all previous collections of it seem to have been in greenhouses in Australia. French, the original collector, took it at Wien Wien (spelled Whian Whian now). I visited Whian Whian. It is now a smooth, rolling cattle country, but was all dense forest in 1857 when French was there. So French must have taken it in the forest.

"I have found the weevil in widely separated forest areas. It is thus well distributed, but scarce, as above observed. It is well under control. Ferns look well everywhere. In some spots I found the weevil more numerous than in others, but nowhere doing damage. The forests where I found it are all very wet. They were dripping with water, and mists and rain kept everything wet during my visit. Yet the parasite does its work and is apparently the main factor operating against the weevil. I also found it in widely separated localities. As the weevil is uncommon I have been unable to secure but a very small quantity of the parasite. On some days, in rich fern growth, I would find only three or four *Syagrius* larvae and as many adults.

"During the entire period I found perhaps two hundred *Syagrius* eggs. All were saved and carefully examined. I have a compound microscope with me. Yet I found no indications of egg-parasitism, and I have found but the one species of larval parasite. The parasitism of the larvae I did find was low.

About 10 per cent were parasitized. Such is often the case when an insect is well under control by its natural enemies. A rapid increase in the weevil can easily bring up the per cent of parasitism. A parasite and its host will frequently go through increases and decreases, first in favor of one and then the other. I think it quite likely that such is the case with the weevil and its parasite here. I found a fair abundance of empty cocoons of the parasite in the old, dead fern stems, indicating a recent high parasitism.

"The parasite is of the Ichneumon type. In one of the packages, containing living material, I include a vial containing three adult parasites. Mr. Timberlake can no doubt determine the sub-family and genus. I would be glad to know what his determination is.

"The female parasite deposits a single, minute, elongate egg on the surface of a well-developed larva. She forces the ovipositor through the fern stem, from the outside, and stings and partially paralyzes the larva. More than one egg is usually placed on the larva, but they are deposited singly. From one to five eggs are usually laid. The egg hatches into a minute, delicate larva, which moves slowly about over the surface of the weevil-larva, feeding externally upon it and ultimately extracting most of its body-fluid and leaving only the hard head and a little tissue. The parasite-larva then spins a white cocoon over or near the remains of the weevil-larva and pupates therein and finally emerges as a mature wasp and gnaws its way out of the fern stem. Mating occurs immediately after mergence. I have not further elaborated on the life history of the parasite, having as yet had but a few days for such observations."

Plant Food Requirements.

HAWAIIAN COMMERCIAL & SUGAR COMPANY EXPERIMENT NO. 7, 1921 CROP.

This was an experiment planned to determine the values of phosphoric acid and potash, when used in different combinations and amounts.

The cane was H 109, planted in June, 1919, and not cut back. The field was harvested in April, 1921.

All the phosphoric acid and potash used in this experiment were applied in

All phosphoric acid and potash used in this experiment were applied in one one dose in September, 1919, while the nitrogen was applied in four doses, in September, November, January, and April.

The amounts of each ingredient used are given in tabular form as follows:

Plots	No. of Plots	Pounds per Acre						
		Sept. 1919	Nov. 1919	Jan. 1920	April 1920	Nitrogen	P_2O_5	K_2O
C	14	286 lbs. N. M........	286 lbs. N. M.	286 lbs. N. M.	323 lbs N. S.	200	0	0
L	13	286 lbs. N. M........ 625 lbs. Acid phos....	" "	" "	" "	200	100	0
M	13	286 lbs. N. M........ 1250 lbs. Acid phos..	" "	" "	" "	200	200	0
N	13	286 lbs. N. M....... 625 lbs. Acid phos.... 200 lbs. Sulp. potash.	" "	" "	" "	200	100	100
O	13	286 lbs. N. M........ 400 lbs. Sulp. potash.	" "	" "	" "	200	0	200

The results obtained from the harvesting of this experiment were as follows:

Treatment	Tons per Acre		
	Cane	Q. R.	Sugar
Nitrogen only	48.2	6.80	7.09
Nitrogen and phos. acid (100 lbs. P_2O_5)	50.0	6.80	7.35
" " " " (200 lbs. P_2O_5)	49.0	6.79	7.22
Nitrogen, phos. acid and potash.......	48.1	6.76	7.12
Nitrogen and potash.................	47.0	6.79	7.08

A chemical analysis of the soil made at the time that the experiment was laid out showed this soil to be high in both phosphoric acid and potash. It was especially high in potash. The total citrate soluble phosphoric acid was 0.021% and the total acid soluble potash was 0.77%. The soils at Waipio have not responded to either phosphoric acid or potash and contain considerably less of those two elements than that given above.

The results at Puunene show some response to phosphoric acid but none whatever to potash. The plots getting nitrogen and phosphoric acid (L and M plots) produced about 0.2 tons of sugar more per acre than did the plots getting nitrogen and potash or nitrogen alone.

The need of phosphoric acid is not very great and is fully supplied by the phosphoric acid in the mixed fertilizer now being used on that plantation.

DETAILS OF EXPERIMENT.

Fertilization — Plant Food Requirements.

Object:

To determine the plant food requirements of sugar cane under conditions at Hawaiian Commercial & Sugar Company.

Location:

Field B.

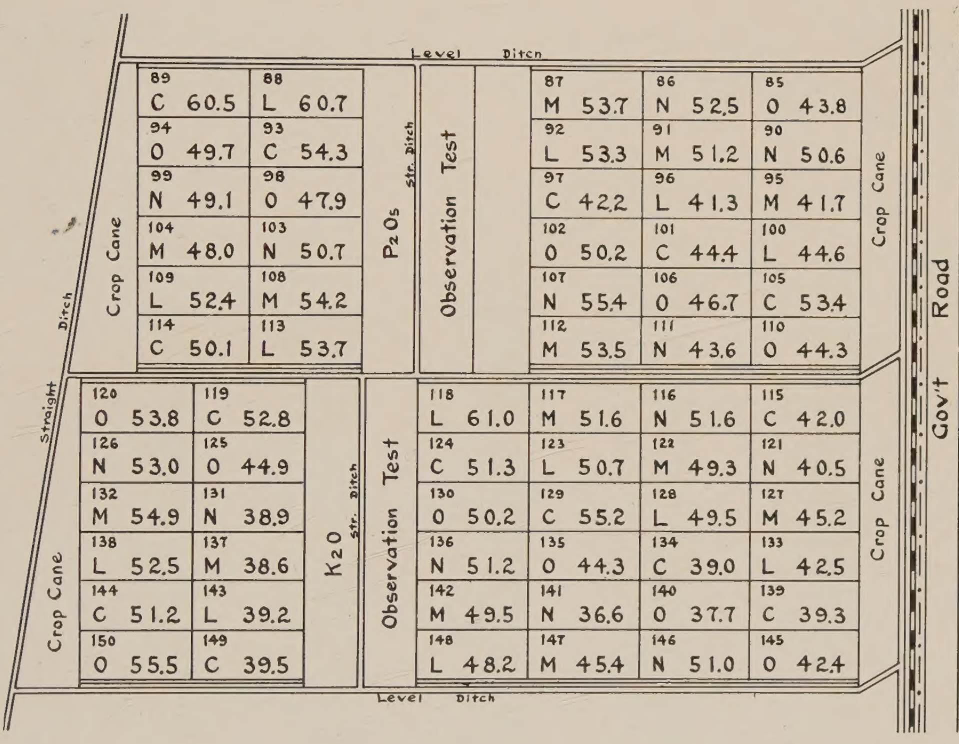
Crop:

H 109, plant.

Plant Food Requirements

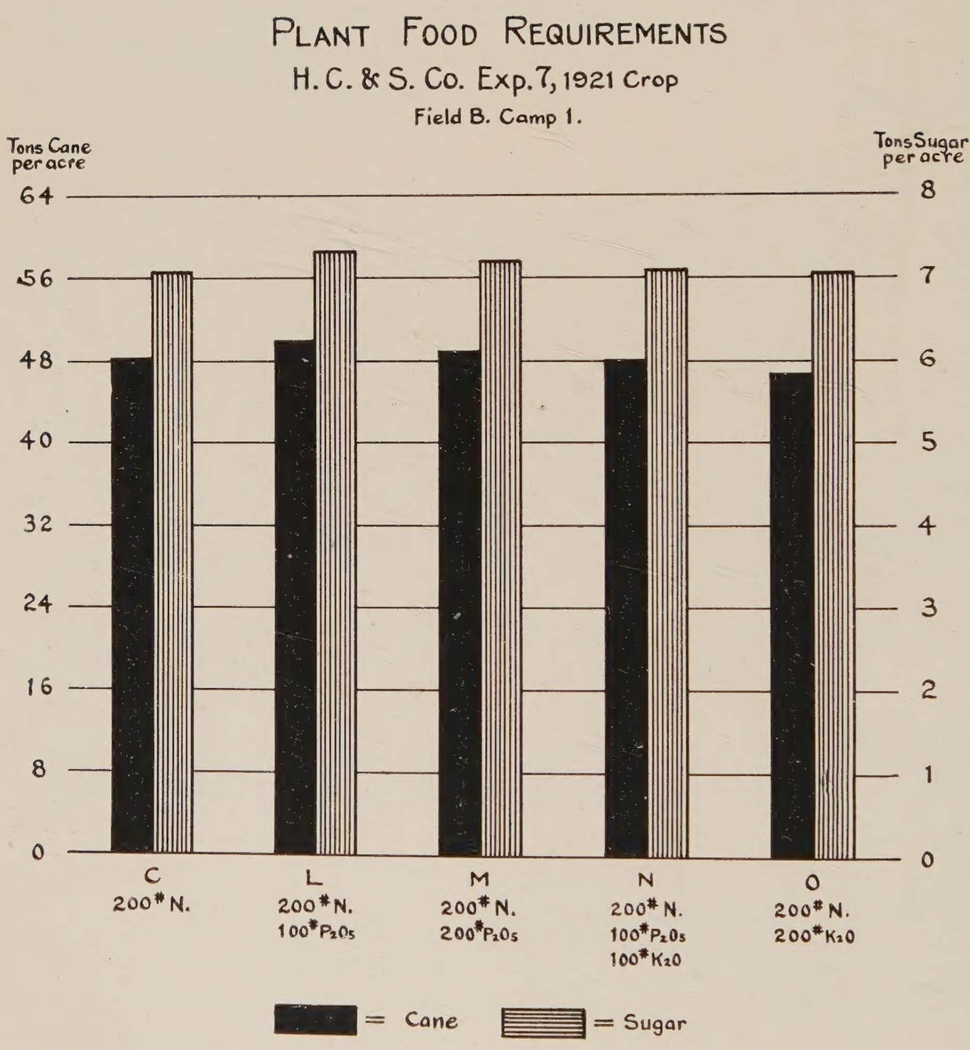
H. C. & S. Co. Exp. 7, 1921 Crop

Field B. Camp 1.



Summary of Results

Plots	No. of Plots	Treatment			Yieds Per Acre		
		Nitrogen	P_2O_5	K_2O	Cane	Q. R.	Sugar
C	14	200*	0	0	48.2	6.80	7.09
L	13	200*	100*	0	50.0	6.80	7.35
M	13	200*	200*	0	49.0	6.79	7.22
N	13	200*	100*	100*	48.1	6.76	7.12
O	13	200*	0	200*	47.0	6.79	7.08


PLANT FOOD REQUIREMENTS
H. C. & S. Co. Exp. 7, 1921 Crop
Field B. Camp 1.
Tons Cane per acre
Tons Sugar per acre
64
56
48
40
32
24
16
8
0
8
7
6
5
4
3
2
1
0
C
200# N.
L
200# N.
100# P2O5
M
200# N.
200# P2O5
N
200# N.
100# P2O5
100# K2O
O
200# N.
200# K2O
= Cane
= Sugar

Layout:

No. of plots = 66.

Size of plots = 1/20 acre; each plot is 6 lines by 2 water-courses, each line being 5′ wide by 72.6′ long.

Plan:

Plot	No. of Plots	Septembr 1, 1919			Nov. 1, 1919	Feb. 15, 1920	April 15, 1920	Total N	Lbs. P. A. P_2O_5	K_2O
		N	P_2O_5	K_2O	N	N				
C	14	50	...	...	50	50	50	200	...	...
L	13	50	100	...	50	50	50	200	100	...
M	13	50	200	...	50	50	50	200	200	...
N	13	50	100	100	50	50	50	200	100	100
O	13	50	...	200	50	50	50	200	...	200

N = 17% mixture = ½ nitrate of soda = ½ ammonium sulphate.
P_2O_5 = Acid Phosphate.
K_2O = Sulphate of Potash.
Experiment planned by J. A. Verret.
Experiment laid out by L. T. Lyman.
Experiment fertilized by W. W. G. Moir.
Experiment harvested by R. S. Thurston.

J. A. V.

Balsa, a New Plant Immigrant.

By H. L. Lyon.

At several points in our journey through the West Indies and Central America we came upon a striking tree which strongly suggested a large Hibiscus. In Cuba we found the tree without flowers or fruit; in Jamaica we saw a few very tall specimens in flower, and in the Canal Zone we finally obtained a few ripe fruits with abundant seeds. We were not aware of the identity of this tree until we returned to Hawaii, when we determined it to be the renowned balsa or corkwood, *Ochroma lagopus*. This discovery was very gratifying to us, for we had made a special search for the balsa and supposed we had failed to find it. Our confusion was due to the fact that we had looked for a tree to fit the description written by Bailey himself for his "Standard Cyclopedia of Horticulture." Bailey states that the fruit is one inch long, and he should have said one foot long.

The seed which we brought back to Hawaii was planted early in May, 1920, and soon yielded an abundance of rapidly growing seedlings. One of these soon pushed its roots through a crack in the bottom of a seed box and established itself in the soil below. As the box happened to be so placed that a tree would not interfere with operations in the nursery, we broke away the

Ochroma lagopus. A balsa tree growing at the Vineyard Street nursery. This tree attained a height of 15 feet in one year from seed.

seed box and allowed the seedling to remain in position without disturbing its roots, and so it has been permitted to grow without being subjected to the usual checks induced by successive transplantings and confinement in pots. The accompanying photograph was taken during May, 1921, when this tree was one year old. The tree then measured 15 feet over all and the stem was slightly over three inches in diameter three feet from the ground. The remarkable growth made by this specimen should be considered ample proof that the balsa can be grown successfully under our conditions of soil and climate.

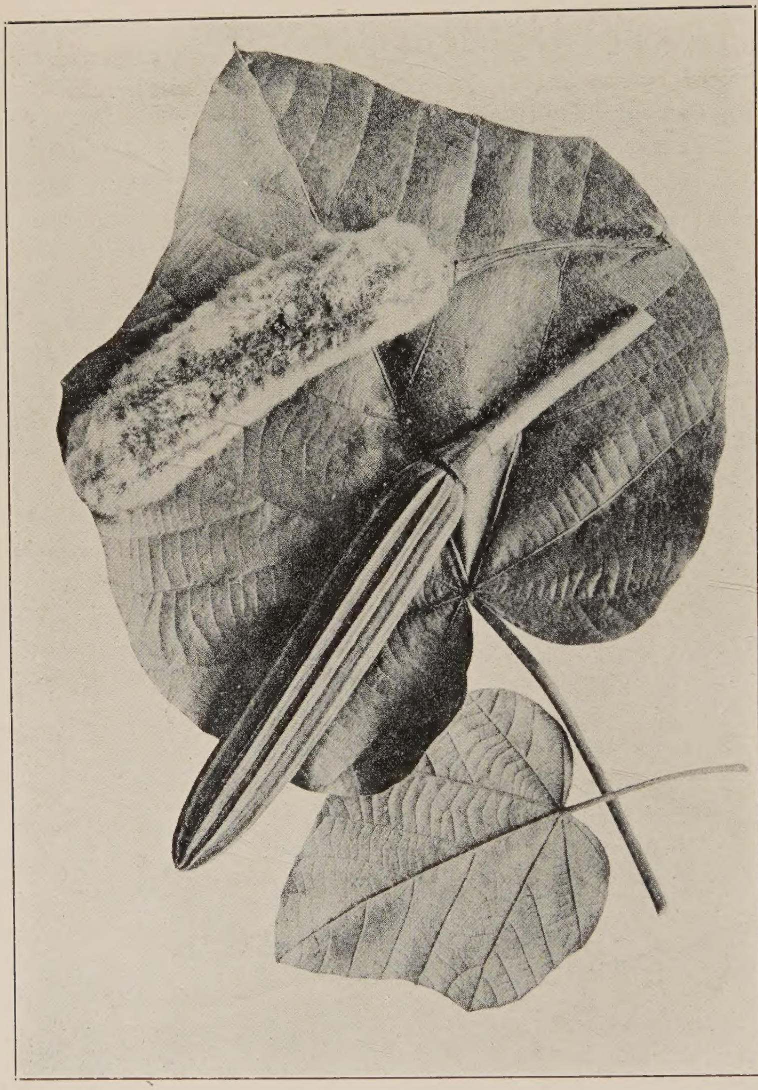
All the rest of our balsa seedlings were held for some time in flats and then transplanted into small pots. This treatment caused them to make subnormal growth to about the same degree that the very favorable conditions in the open ground caused the single specimen described above to make abnormal growth. Fifteen of the potted trees were planted out in the H. S. P. A. arboretum at the head of Manoa Valley during February, 1921, and these are now making very strong and rapid growth, showing every indication of being well adapted to the conditions there. Some eight hundred trees were also planted out about the same time in the forests of Hawaii and Kauai, but we have no recent reports on their condition.

During the winter months Japanese beetles attacked and riddled the large leaves of the rank growing tree, but did little damage to the firmer leaves of the near-by potted plants in the nursery. Despite the fact that the beetles removed most of the green tissue between the veins, every bit of the tissue not actually removed remained alive and continued to function; and even after the tree had made a strong spring growth, producing an abundance of new and uninjured leaves, it still held the old perforated leaves. The photograph reproduced on page 12 shows one of these leaves as it appeared June 1.

The following description of the balsa is drawn from the literature and from the writer's notes taken in the field.

Ochroma lagopus Swartz. Family *Bombacaceae*.
An upright branching tree attaining, in exceptional specimens, a height of 60 to 70 feet and a trunk diameter of 2 feet and, in average specimens, a height of 40 to 50 feet and a trunk diameter of 1 foot; leaves orbicular cordate, entire, or three or five angled or lobed, often a foot or more broad with petioles 10 to 30 inches long, palmately veined with seven or nine primary nerves, more or less pubescent on both surfaces but more densely so beneath; flowers large, terminal; sepals five; petals five, obovate, wavy, light yellow or pale brown, 4 to 6 inches long; stamens united into a column which carries on its upper half numerous large, 1-celled anthers; ovary five-celled, each cell containing many ovules; fruit a deeply grooved, sub-cylindrical capsule, 8–12 inches long and 1 inch in diameter, splitting longitudinally into five valves; seeds very small and very numerous, closely packed in a copious soft brown wool or down which serves to buoy them up and insures their wide distribution by the wind. Native to tropical America. Common names Balsa, Corkwood, Down-tree, Ceibon Lanero, Guano, Corcho.

The balsa supplies a variety of useful products; the wood is very light but strong and elastic; the fiber or down surrounding the seeds is used in upholstering and may be spun and woven into cloth; while the bark and roots have medicinal properties.



Ochroma lagopus. Leaves and fruit. The lower fruit is still green, while the upper fruit is dry and has begun to open along the sutures, exposing the copious down which at once begins to expand, giving the fruit the appearance of a large cylindrical brush or kahili. (From the Report for 1917–1918 of the Agricultural Experiment Station of Cuba.)

In their description of balsa, Cook and Collins[1] write: "The wood is white, stained with red, luminous in aspect, sometimes silky. It is very porous and the lightest of all woods, lighter even than true cork, . . ." and they give its specific gravity as 0.12. Since the specific gravity of cork is 0.24, a cubic foot of the latter material would weigh just twice as much as a cubic foot of dry balsa wood; while a cubic foot of Douglas fir (Nor'west, sp. gr. 0.51) would weigh a little more than four times as much.

[1] Cook, O. F., and Collins, G. N., Economic Plants of Porto Rico.

It is rather strange that the balsa has not been previously introduced into Hawaii, or if it has, that it has not become established here. Producing seeds in enormous numbers and providing, as it does, for their wide distribution by the wind, this tree should spread rapidly after it has once become established on our watersheds. It should prove a very valuable component of the barrier forests which we must build along the makai borders of all our forest areas.

The Lightest Wood in the World.*

Balsa, the tropical wood lighter than cork, has already been described in these columns. According to a writer in Raw Material (New York), it is now on the American market for a variety of special uses that require buoyancy, non-conductivity for heat, smoothness, softness and lightness, and speed in working. Balsa is, so far as known, the lightest wood that grows. It averages in weight about one-third less than cork. This lightness results from its peculiar cellular structure, which is said to differ from that of any other wood. The cell walls are extremely thin; and where ordinarily there are woody fibers, there is in balsa practically no lignification. This structure confines within its large, barrel-shaped cells a quantity of "dead" air, which represents 92 per cent of the total volume of wood and which accounts for its remarkably high insulating value. To quote the article:

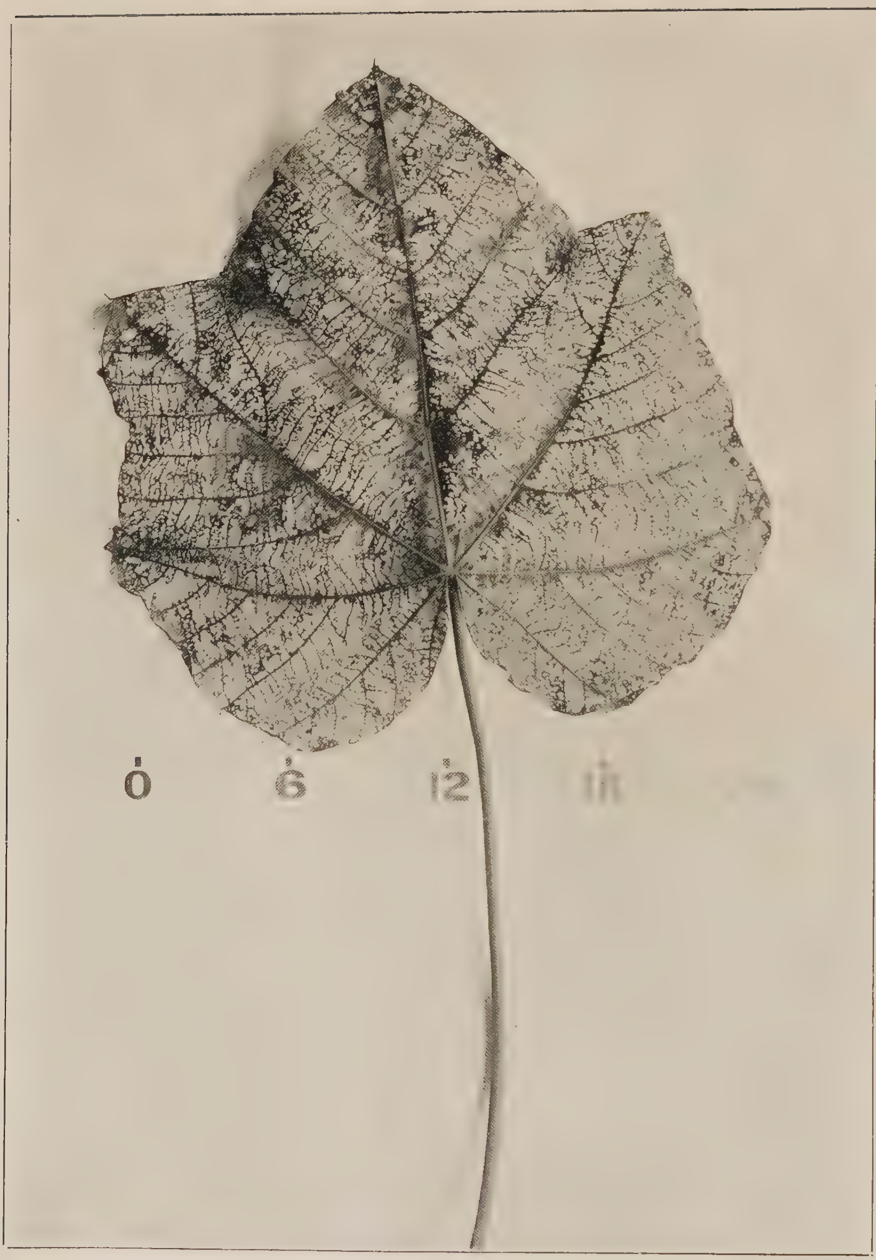
"In its natural state balsa rots quickly, and ordinary methods of preservation by painting or otherwise, are ineffective in preventing deterioration. After extended experimentation in the treatment of balsa, a process of wood preservation has been developed which meets the requirements of balsa and its uses, giving adequate protection and permanency of quality to the wood. The process thoroughly impregnates all parts of the wood with a thin coating which does not appreciably increase its weight. Treated balsa is water-resisting and is not subject to the attacks of insects or the bacteria of decay.

"Combined with its light weight and its quality of insulation against heat, balsa possesses a structural strength which, pound for pound, is greater than that of any wood. In actual test, balsa shows a strength per square inch fully one-half the strength of spruce.

"Extensive tests have shown that balsa has an insulating efficiency at least equal to that of any other commercially used product. The heat conductivity of water is such that very small percentages of moisture absorption greatly lower the quality of an insulation. Balsa is so thoroughly waterproofed that its orignal efficiency is maintained."

Treated and waterproofed, balsa is now being used, we are told, as insulating material for refrigerated spaces in over fifty ships. The early extension of its industrial use to refrigerator-cars and trucks is expected, as well as to all

* The Literary Digest for April 30, 1921.



Ochroma lagopus. A balsa leaf which has been riddled by Japanese beetles. The insects removed all of the soft tissue between the veins, but the balance of the tissue remained alive and continued to function.

insulated compartments, from small parcel-post boxes for foodstuffs, etc., to cold-storage warehouses. Insulation is, however, only one of the many uses to which balsa has already been put, and further study of its properties is constantly disclosing new directions in which it will prove of value. The writer goes on:

"Balsa first attracted attention by reason of its light weight, which suggested its use in life-preservers and other equipment for saving lives at sea. During the war, large numbers of balsa rafts, elliptical rings of solid, treated balsa, waterproofed and covered with canvas, were a familiar part of the safety equipment carried on board the American transports. Balsa fenders are used on two types of life-boats. The great buoyancy of this wood has also been made use of in a line of water sporting goods, such as surf boards and decoys.

"Excellent proof of the effectiveness of the waterproofing treatment was shown during the war by the 70,000 mine-buoys whose use largely made possible the 250-mile 'mine barrage' across the North Sea. This was said to be the only type of float which could withstand the long submersion and the crushing effect of depth charges.

"Of the miscellaneous uses dependent upon its light weight, balsa has already been successfully employed in the construction of hydroplane pontoons and for filling out stream-lines of airplane struts.

"The smoothness and softness of balsa have led to its increasing use in the protection during shipment of highly finished furniture surfaces, such as phonographs and pianos. Not only is the wood smooth, but it has remarkable elasticity, and this is not in the least altered by subsequent compressions.

"The facility and speed with which treated balsa may be worked either by hand or with wood-working machinery have made it particularly adaptable to use in toy manufacture, such as toy airplanes. It has also been used for the throats of phonographs, which in certain makes must be hand-carved."

[H. L. L.]

The Production of Dairy Roughages for Hawaiian Plantations.

By John H. Midkiff.

A number of plantations in various parts of Hawaii are operating dairies, or are planning to do so. For the economical production of milk, a constant supply of good roughage is absolutely essential. It makes no difference what concentrates may be fed, a cow must have plenty of roughage to do well. The questions before several plantation men now are: "What shall these roughages be? What feeds, adapted to my soil and climatic conditions, can I raise that will give me the biggest returns in milk?"

Where alfalfa can be easily raised, without too great a drain upon the labor

supply, and at a reasonable cost, it is the ideal dairy crop. Cows will probably produce more milk on it than on any other roughage that can be raised. But it is, in many places, hard to raise. It needs considerable attention,—weeding and irrigating,—and is much more easily killed out by certain pests than some of the other forages produced here. Alfalfa is now being raised successfully on all of the principal islands. In most cases it is irrigated. Men who are not in a position to irrigate this crop should not plant a very large area of it, unless the rainfall is large and fairly constant. It will not do well in a sour soil, and it should not be planted where the water table is so near the surface that good drainage is impossible.

Considering the fact that alfalfa does require so much attention, that it is not as hardy as some other forage plants, and that some growers who now have good stands of the plant are finding it more profitable to grow other leguminous roughages than to weed and irrigate the alfalfa, we do not recommend it for most plantations. However, if the planter is willing to devote to this crop the labor and money that it requires, he will get the best dairy roughage obtainable.

We believe that the pigeon-pea, if fed in conjunction with certain other bulky roughages, is one of the best and safest leguminous crops for this purpose. This plant contains a high percentage of protein. Actual feeding tests have shown that it is a wonderful milk producer. It is comparatively easy to raise and requires little attention, once the plant is well started. It bears heavily and cows like few feeds better.

Perhaps the best recommendation that we can give the pigeon-pea is the fact that men who gave it a trial a year or two ago, are now spreading the crop rapidly. Many are now planting a strain developed by F. G. Krauss at the Haiku Substation of the United States Experiment Station. This variety bears very heavily and matures early, and we would strongly recommend it to anyone who intends to plant pigeon-peas, as we believe it to be the best now obtainable.

Pigeon-peas are easily raised. After the soil is well prepared the seed should be drilled in rows at the rate of ten or twelve pounds per acre. If the soil is very dry an irrigation or two will help germination. The crop should be given considerable attention until it has made a good growth. When it is well started, however, its hardiness is remarkable. It chokes out many weeds and makes a fair growth, even when given no cultivation. When it gets four or five feet tall it can be cut off about a foot above the ground, and the entire plant—leaves, seed pods, stalks and all—run through a cutter and fed. Shoots will start from the stumps and about two months later another crop can be removed. This ratooning can be continued successfully, under normal conditions, for years. Many dairymen pasture the plant and cut it back only when it gets ahead of the animals and gives indication of becoming too woody.

Since pigeon-peas make a highly nitrogenous feed, best results will be obtained by feeding with it some nonprotein roughage, such as Sudan grass, Elephant grass, cane tops or Uba cane. If good, fresh, green cane tops can be secured they are entirely satisfactory. These are also successfully fed as silage at Kekaha, and dried and baled at Hawaiian Commercial & Sugar Company. As a feed for dairy animals, experience would indicate that the fresh tops or the silage would be superior to the cured and baled material.

Many plantations cannot get good cane tops at all times, however, and some do not care for cane tops either as silage or as dried hay. Under such conditions Elephant or Napier grass affords a good substitute. This grass grows well under a wide range of conditions. It will grow near the beach, providing the salt spray does no strike it too much, and it does well, better than most green fodder crops, at fairly high altitudes. It is high in carbohydrates and low in proteids. Pigeon-peas and alfalfa are high in proteids and low in carbohydrates. Chopped and fed together, pigeon-peas or alfalfa and Elephant grass make very nearly an ideal roughage for dairy cows.

Elephant grass is a cane-like, non-saccharin grass. Cuttings may be planted in the same manner as those of the sugar cane or they may be planted at a slant in the furrows with one joint left above ground. The former method is probably the better of the two. If the seed is planted end to end, in rows four or four and a half feet apart, and covered about two inches deep, a heavy growth should result, providing good seed is used. The seed should be taken from well matured canes. It is not essential that top seed only be used, as body seed is perfectly satisfactory, providing care be taken to avoid injured and dried-out eyes.

Elephant grass may be pastured or the grass may be cut when it is about five feet high, chopped up and fed to the animals. The grass should be cut close to the ground, just as cane is. If cut in this manner and given proper care, this crop will give more feed per acre than if pastured. If pastured it should be allowed to grow at least four feet high before the cattle are turned in, and it must not be pastured so heavily that the animals kill it out. On the other hand if not enough cows are pastured on it to keep it down fairly well, too large and coarse growths will be made and it will be necessary to cut the woody canes back occasionally.

While we believe that Elephant grass is about the best grass to raise, under general conditions, to supplement the leguminous forage plants, there are other grasses that do fairly well, such as Sudan grass or Uba cane. The Uba cane grows more slowly and yields less under normal conditions than does the Elephant grass. At the Haiku Substation, F. G. Krauss found that Elephant grass matured in half the time required for Uba cane, and the Uba cane when it did mature produced only half as large a crop; thus the Elephant grass produced four times as much feed as the Uba cane. But it is generally believed that Uba cane will do better than Elephant grass under unfavorable conditions. So on very dry soils, on very wet and heavy soils, on lands near the beach where the salt breezes hit the cane, and at very high altitudes, the Uba cane would probably give better results and a larger yield than the Elephant grass.

Sudan grass is a smaller, finer plant than Uba cane or Elephant grass, and it cannot be expected, under ordinary conditions, to produce as much per acre. It is now being raised and fed with good results, supplementing alfalfa, to several herds of dairy cows in Hawaii. If produced under very dry conditions, Sudan grass, as well as nearly all other sorghums, may develop prussic (hydrocyanic) acid, which is very fatal to livestock. This point must be carefully watched in feeding any kind of sorghum roughages.

An experiment conducted by Mr. Krauss at Haiku on the feeding of Yellow Tip cane to dairy cattle is of interest. He found that this cane, under condi-

tions which practically prevented the growth of forage plants, made an exceptionally good dairy roughage. It was of course necessary to cut the cane before it became too hard and woody. Then, instead of employing the ordinary feed cutter, the cane was shredded so as to leave no large pieces of woody fiber for the cows to eat. The first crop was cut about four months after planting, the succeeding crops requiring about the same time, making three crops a year. Mr. Krauss found that he got more feed by cutting three times a year than he did by cutting four times. The cane may be ratooned, under this system, a great many times, providing it is given reasonable cultivation, irrigation, and ferilization.

Too many people think that sugar cane is the only crop in Hawaii that requires fertilizing. Cane can be grown without fertilizers, but maximum crops of it are not obtained under such conditions. The same is true of grasses and other forage crops. It will often pay to fertilize pigeon-peas and Elephant grass. Since the grasses are cut more often, smaller and more frequent doses of nitrogen will undoubtedly be more practical than one big dose a year. A little close observation upon the effect of various sized doses given at different times will give the planter much information on this point.

Before planting these forage crops it will be a good insurance to add some phosphates to the soil. Reverted phosphate or a mixture of half reverted and half acid phosphate applied at the rate of 500 or 600 pounds per acre will not cost much and might be beneficial. Mr. Krauss reports from Haiku, Maui, that he got good returns from the use of phosphates in this manner, whether applied to soils high or low in phosphorus.

Value of Press Cake and Varying Amounts of Fertilizer.

Waipio Experiment U, 1921 Crop.

This was an experiment to determine the value of press cake in increasing crop yields when used without fertilizer and with varying amounts of fertilizer. A comparison was also made between varying quantities of fertilizer.

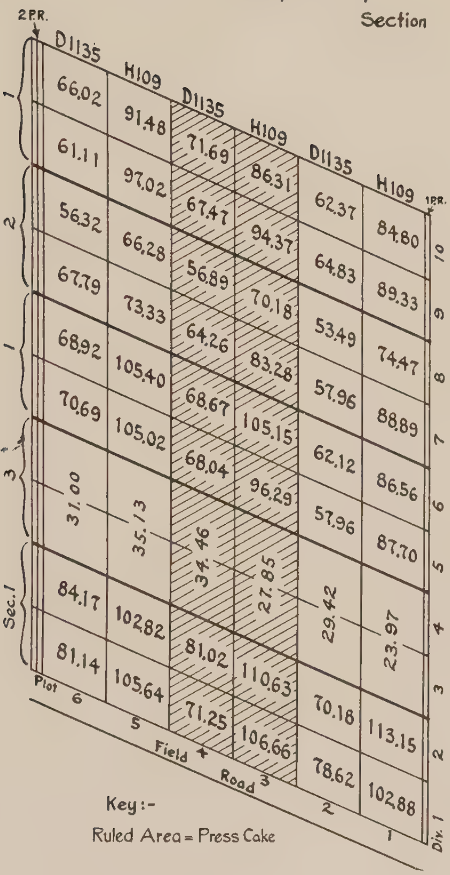
The cane was D 1135 and H 109, 4th ratoons, long, and was 21 months old at harvest, not having been cut back.

A uniform application of 10 tons per acre of press cake was made to a portion of the plots. The cane had not been hilled. A small trench was dug along one side of the cane row, where the press cake was applied and then covered. A number of press cake plots received no further fertilization; another portion received nitrogen only, at the rate of 135 pounds per acre (870 pounds nitrate of soda), while the remaining plots received nitrogen at the rate

VALUE OF PRESS CAKE & VARYING AMOUNTS OF FERTILIZER.

Waipio Experiment U, 1921 Crop

Section 35.



Variety	Treatment	Tons Cane Per Acre	Gain Due To Mud Press
H 109	10 Tons Mud Press + No Nitrate of Soda	35.1	
H 109	No Mud Press + No Nitrate of Soda	25.9	+ 9.2
D1135	10 Tons Mud Press + No Nitrate of Soda	34.5	
D1135	No Mud Press + No Nitrate of Soda	30.2	+ 4.3
H 109	10 Tons Mud Press + 870# Nitrate of Soda	76.7	
H 109	No Mud Press + 870# Nitrate of Soda	75.8	+ 0.9
D1135	10 Tons Mud Press + 870# Nitrate of Soda	60.5	
D1135	No Mud Press + 870# Nitrate of Soda	58.9	+ 1.6
H 109	10 Tons Mud Press + 1740# Nitrate of Soda	100.1	
H 109	No Mud Press + 1740# Nitrate of Soda	97.7	+ 2.4
D1135	10 Tons Mud Press + 1740# Nitrate of Soda	71.4	
D1135	No Mud Press + 1740# Nitrate of Soda	69.0	+ 2.4

of 270 pounds per acre (1740 pounds nitrate of soda). The nitrate of soda was in all cases applied in two doses—two-thirds in August, 1919, and one-third in February, 1920.

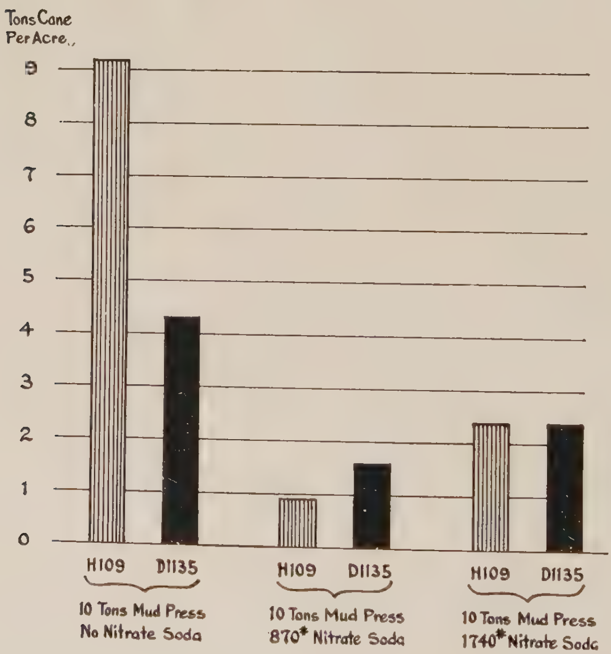
It was not possible to take "car samples" of juice at the mill. The sugar yields are therefore not given here, as small hand mill samples are not considered sufficiently reliable.

The yields of cane per acre for the different treatments are given as follows:

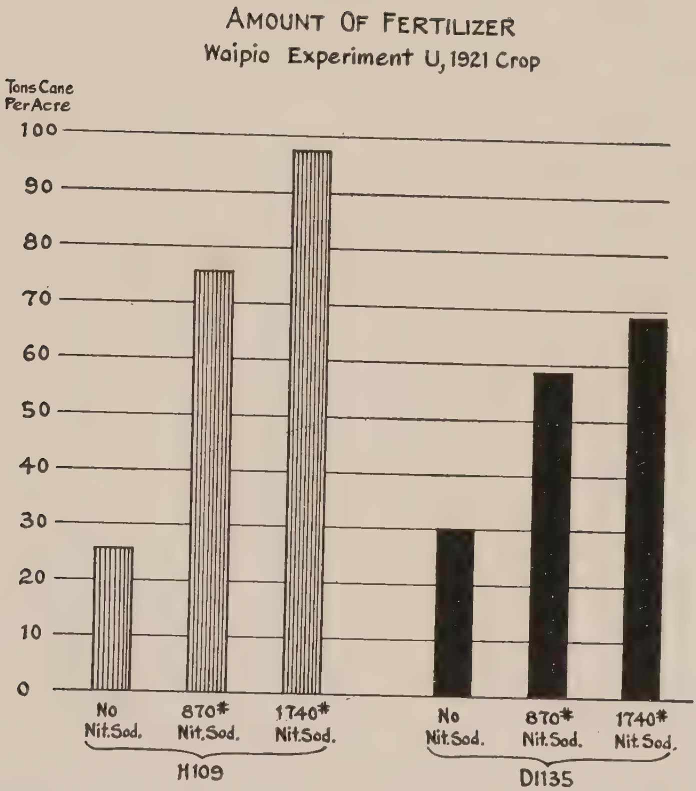
Variety	Treatment	Tons Cane per Acre	Gain Due to Press Cake
H 109	10 tons P. C. + no N. S.	35.1	
"	No. P. C. + no N. S.	25.9	+9.2
D 1135	10 tons P. C. + no N. S.	34.5	
"	No. P. C. + no N. S.	30.2	+4.3
H 109	10 tons P. C. + 870 lbs. N. S.	76.7	
"	No. P. C. + 870 lbs. N. S.	75.8	+0.9
D 1135	10 tons P. C. + 870 lbs. N. S.	60.5	
"	No. P. C. + 870 lbs. N. S.	58.9	+1.6
H 109	10 tons P. C. + 1740 lbs. N. S.	100.1	
"	No P. C. + 1740 lbs. N. S.	97.7	+2.4
D 1135	10 tons P. C. + 1740 lbs. N. S.	71.4	
"	No P. C. + 1740 lbs. N. S.	69.0	+2.4

Chart Showing Gains Due To 10 Tons Of Mud Press Per Acre In Addition To Varying Amounts Of Nitrate Of Soda.

Waipio Experiment U, 1921 Crop



These results indicate the value of 10 tons per acre of press cake to be from 5 to 10 tons of cane when no other fertilizer is used. With medium to heavy fertilization the gains are much less. We see from these results that press cake cannot be expected to take the place of readily available plant food from commercial fertilizers, unless, perhaps, where press cake is used in enormous quantities. It would seem to us that the proper way to get the most value



from this material would be in its use on the very poor fields only and in "building up" bad spots in the more accessible parts of the plantation.

The results obtained from the use of varying amounts of nitrate of soda are given below:

Treatment	Tons Cane per Acre	
	H 109	D 1135
No nitrate of soda	25.9	30.2
870 lbs. nitrate of soda	75.8	58.9
1740 lbs. nitrate of soda	97.7	69.0

The most striking thing about these results is the different behavior of the two varieties under the different treatments. Without fertilizer D 1135 was slightly better than H 109, while under intensive fertilization H 109 produced one-third more cane and about double the sugar produced by D 1135 under the same conditions.

Experiment planned by J. A. Verret.
Conducted by R. M. Allen.
Harvested by A. Paris.

J. A. V.

Nitrogen, Phosphoric Acid, and Potash.

Waipio Experiment V, Crops 1917, 1918, 1919, and 1920.

This was an experiment to determine the values of nitrogen, phosphoric acid and potash, alone and in different combinations, for soils of Waipio. The canes involved were Yellow Caledonia and D 1135. This experiment has now been carried on through four crops without change. The crop just harvested was fourth ratoons, so the field was plowed and planted to H 109. The different fertilizer treatments will be continued unchanged.

The X plots received 150 pounds of nitrogen, 75 pounds of phosphoric acid and 75 pounds of potash per acre. The A plots received nitrogen only at the rate of 150 pounds per acre; the B plots received the same amount of nitrogen plus 75 pounds of potash; the C plots the same nitrogen treatment plus 75 pounds of phosphoric acid instead of potash; the D and E plots received no potash or phosphoric acid, but 200 and 250 pounds of nitrogen per acre, respectively.

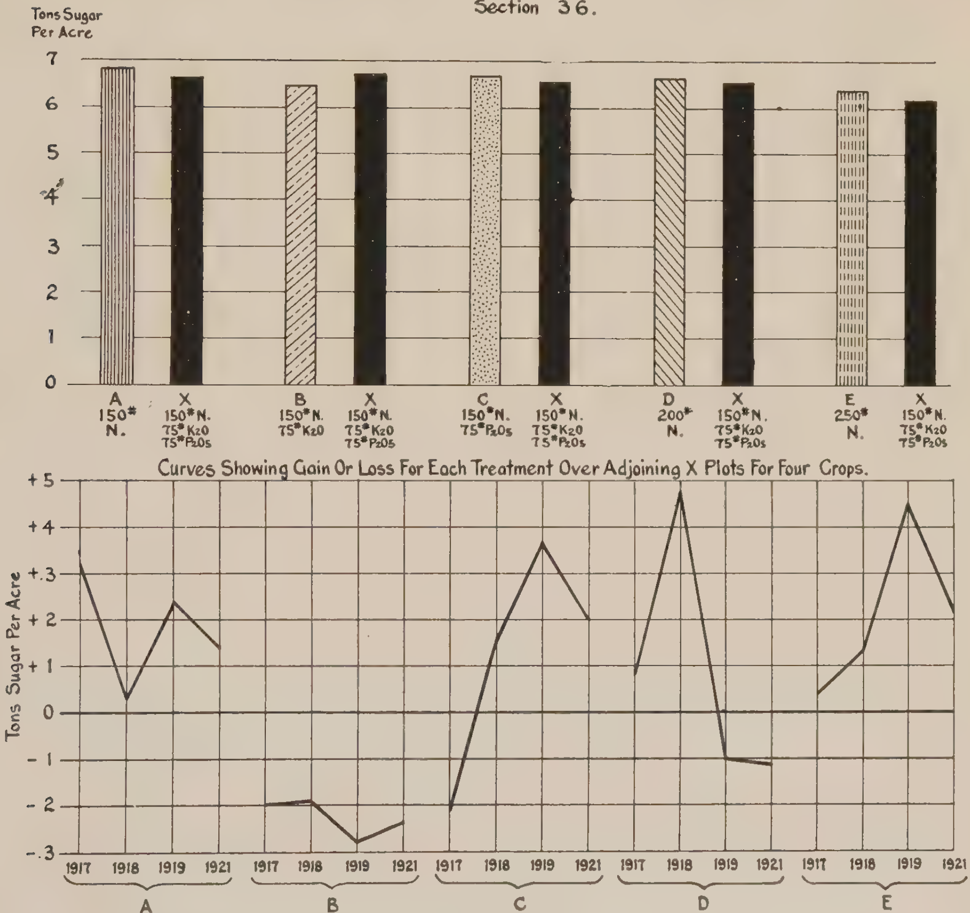
The results obtained from the four crops show no great variations for the different treatments. In no case was the difference in yield much greater than would normally occur were all the plots receiving similar treatment.

The results obtained from the four crops harvested are given in tabular form as follows:

Plots	Treatment	Tons of Sugar per Acre				
		1917 S. R.	1918 S. R.	1919 S. R.	1921 L. R.	Average
A	150 lbs. N.	6.20	5.80	6.08	9.31	6.84
X	150 lbs. N. 75 lbs. P_2O_5, 75 lbs. K_2O	5.88	5.77	5.84	9.17	6.67
B	150 lbs. N. 75 lbs. K_2O	5.86	5.76	5.82	8.64	6.51
X	150 lbs. N. 75 lbs. P_2O_5, 75 lbs. K_2O	6.06	5.95	6.10	8.88	6.75
C	150 lbs. N. 75 lbs. P_2O_5	5.52	5.99	6.17	9.25	6.72
X	150 lbs. N. 75 lbs. P_2O_5, 75 lbs. K_2O	5.73	5.83	5.80	8.95	6.58
D	200 lbs. N.	5.50	6.04	6.07	9.14	6.68
X	150 lbs. N. 75 lbs. P_2O_5, 75 lbs. K_2O	5.42	5.56	6.17	9.25	6.60
E	250 lbs. N.	4.87	5.84	5.95	9.10	6.44
X	150 lbs. N. 75 lbs. P_2O_5, 75 lbs. K_2O	4.83	5.71	5.50	8.88	6.23

In a broad way these results would indicate that nitrogen is the limiting factor in Waipio soils and that they require very little, if any, phosphoric acid and potash. But a close study of the results (see series of curves on page 21) tends to point to the need of some phosphoric acid, while potash is of no value whatever. This is seen by comparing the B and C plots. Dropping phosphoric

CHART SHOWING AVERAGE YIELD OF EACH TREATMENT FOR 4 CROPS
Waipio Exp. V, 1917, 1918, 1919 & 1921 Crops
Section 36.



acid (B plots) caused a loss as compared to complete fertilizer, but phosphoric acid and nitrogen (C plots) gave better yields than the complete fertilizer, and the gains were greater during the last two years than during the first two, showing a growing need for phosphoric acid.

This experiment will be continued to determine how long maximum crops can be grown on this soil with nitrogen alone, and then should be continued to note how fast crop production drops when either phosphoric acid or potash, or both, becomes the limiting factor.

DETAILED ACCOUNT.

Object:

1. To find the relative value of nitrogen, phosphoric acid and potash on ratoons of Yellow Caledonia and D 1135.
2. To find the immediate and ultimate effect of omitting phosphoric acid or potash, or both, from the fertilizer applied.

Location:

Waipio Substation, Section 36.

Layout:

Sixty plots, each 1/30 acre net, 8 rows to each plot.

Plan:

Fertilization Pounds per Acre

Plots	No. of Plots	Nitrogen	Phos. Acid	Potash
A	6	150 lbs.	0	0
B	6	150 lbs.	0	75 lbs.
C	6	150 lbs.	75 lbs.	0
D	6	200 lbs.	0	0
E	6	250 lbs.	0	0
X	30	150 lbs.	75 lbs.	75 lbs.

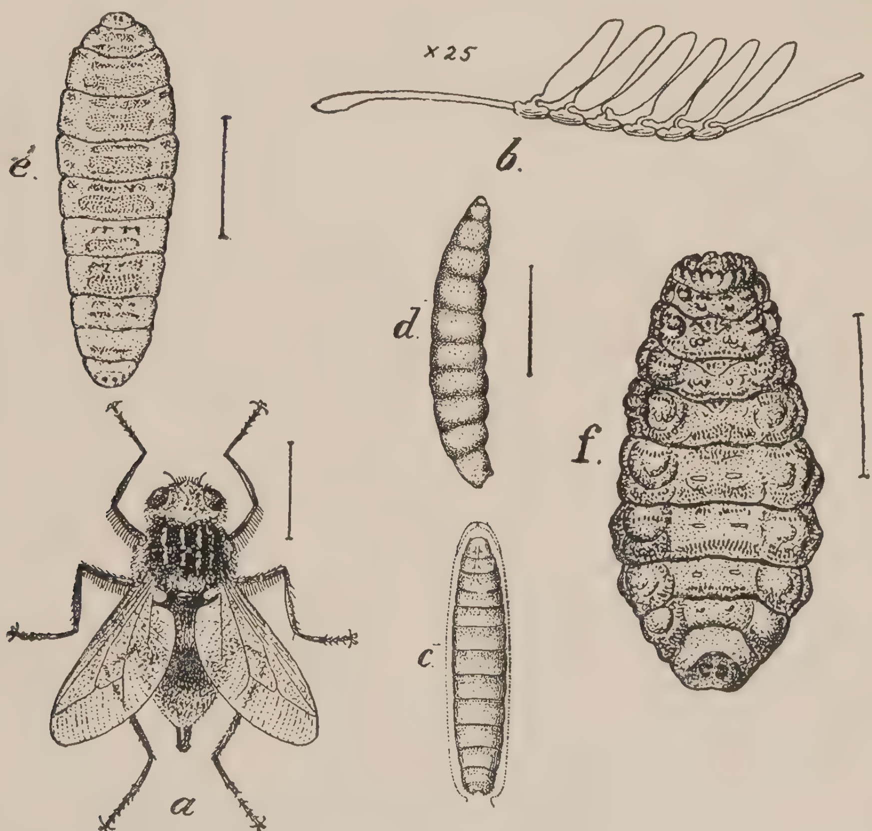
J. A. V.

Ox Bot-Fly or Warble Fly, Hypoderma Lineata.

By O. H. Swezey.

While on the Island of Kauai, May 3 to 7, 1921, I saw cows with warbles in their backs in dairies on two different sugar plantations. In one of the dairies only a very few were observed; but in the other dairy several of the cows were infested with warbles. One cow had half a dozen of them.

These cows had lately (four to six months previously) been imported from the mainland, and no doubt were infested with the warbles before they were



The warble fly (*Hypoderma lineata*): *a*, adult female; *b*, eggs attached to hair, × 25; *c*, larva as seen in egg; *d*, larva from esophagus of an ox; *e*, next stage of larva from beneath the skin of the back; *f*, larva at the stage when it leaves the back of host and falls to the ground. All enlarged (after Riley.)

shipped. Different ones who had had more or less to do with cattle for some years said that they had never found any of the warbles in cattle raised on Kauai. Hence it can be inferred that this fly has not become established there, though it may have had opportunities to do so from cattle that were already infested when imported. No doubt this has occurred many times similarly to the present instances.

As the warble maggots may be present in their host for several weeks or a few months without developing sufficiently to be noticeable, it is easily possible that infested cows could be brought in without it being known till later on, when the maggots had developed enough to produce the lumps and ulcers on the animals' backs.

This pest is a large fly, somewhat related to the bot-fly of the horse. Like it, the adult fly lays its eggs on the hairs of the host animal, usually on the shoulders, front legs near the heel, or other parts where they will be licked by the animal and thus gain entrance by way of the mouth. The young maggots bore through the wall of the gullet, and gradually work their way through the tissues up to the back, where they finally grow and produce noticeable swellings, which finally become ulcers and make perforations in the skin, from which the large, full-grown maggots emerge and fall to the ground. They bury themselves in the ground for pupation, and after three to six weeks issue as adult flies.

In the temperate climate of the United States the eggs are usually laid in early summer. The larva is well developed when the egg is laid, and when the cattle lick themselves the young larvae are removed from the eggs and taken into the mouth. They are armed with many minute spines, which permit them to adhere to and to penetrate the walls of the esophagus. For several months they wander slowly in the tissues of the host, eventually in late winter reaching a point beneath the skin in the region of the back. The growth has been slow up to this time, but now it becomes more rapid, and soon are formed the strongly spined grubs which occupy the swellings or ulcers so conspicuous on the backs of infested cattle. They become full grown in the spring months and issue from the perforations or openings of the ulcers to pupate in the ground. This occurs from March to May, and the mature flies appear about a month later, being most abundant in the Central States in July or August. Eggs are then laid for the next generation, there being but one generation per year.

If these flies should become established in the dairies and cattle ranges of the Hawaiian Islands, their breeding might not be so seasonal, and possibly there would be more than the one brood per year. Perhaps their life cycle might be shortened and it might be that they would develop continuously without respect to seasons, as do the house-fly and horn-fly.

This pest causes a gerat deal of loss to cattle in the States. At many of the beef packing houses the value of the hides is greatly reduced, often one-third, and the meat is also spoiled in the regions occupied by the warbles; thus many thousands of dollars' loss occurs. They are also very deleterious to dairy cows when abundant.

There are no definite records of these flies having become established in the Hawaiian Islands. None of the insect collections have specimens of the flies collected here.

In the Annual Report for 1907 of the Hawaii Agricultural Experiment Station, Van Dine says, in listing cattle pests:

> "Possibly these flies have been brought to Hawaii with imported cattle from the western coast of the mainland. But apparently they have not become established."

In a report to the Hawaiian Live Stock Breeders' Association for the year 1907, Dr. Norgaard and Van Dine mention the warble fly as a cattle pest which does not seem to become well established here, being apparently controlled by some natural enemy. In this report it is stated that, "Though no regulation has been promulgated to that effect, the office of the Territorial Veterinarian has made it a rule to thoroughly disinfect the hides of all imported cattle immediately after arrival and to destroy all warbles which at that time have made their appearance under or in the hide."

In the Proceedings of the Hawaiian Entomological Society, III, page 113, 1915, is a note by Mr. Ehrhorn, relative to observations made by him several years previously on Molokai. He is reported as saying that the work of this fly is only occasionally observed on Molokai and the large numbers of ants on the cattle ranges destroy the larvae as they emerge and fall to the ground to pupate.

Whether established here or not, or whether kept well controlled by some natural enemies, it is advisable to destroy all warbles that are found in imported cattle, so as to prevent or lessen the chances of their becoming established on the cattle ranges of our Islands. Besides, imported cattle are usually of high valuation, and for their sakes close examination should be made for warbles and destroyed wherever found. They may be destroyed by pressure or by insecticidal treatment. When the perforation in the skin is large enough, the maggot may be forced out by careful pressure, and stepped on when it falls to the floor or ground. If necessary, the opening may be enlarged a little by using a round stick bluntly pointed, as a probe. If the opening is very small, the maggots may be killed by rubbing in a little kerosene or the application of mercurial ointment, as they have their breathing pores directed towards the opening and would easily succumb to the treatment. It thus becomes an easy matter to destroy these pests in cows which are under daily observation, as in milking sheds, and all stable men should become familiar with the manner of recognizing the presence of the pests and the methods of relieving the cattle of their annoyance. It should be an easy matter to rid a herd of them if these precautions are taken.

The Inheritance of Productivity in Potatoes.*

According to a note published in the Indian Scientific Agriculturist, November, 1920, from his investigations conducted in Germany into the inheritance of productivity in potatoes in connection with the choice of tubers for planting purposes, C. von Steelhorst came to the conclusion that the size of the tubers used for planting has a decided influence on the yield of the descendants, the large tubers being usually more productive than the small ones. The pro-

* *Agricultural News, West Indies,* Vol. XX, No. 493. 1921.

ductivity of parent plants, however, appears to be of even greater importance, for in the tests made, small tubers from productive parent plants nearly always gave more productive descendants than those of large tubers from slightly productive plants. For example, whereas the smallest tubers (average weight 33 grams) of productive plants had descendants that yielded on an average, 518 grams of tubers per plant, the relatively large tubers (average weight 84 grams) of poor productive plants had descendants that produced only an average of 88 grams of tubers per plant. [J. A. V.]

Potato Improvement by Hill Selection.*

The Utah Agricultural College Experiment Station has recently issued a bulletin by Mr. George Stewart on "Potato Improvement by Hill Selection."

This bulletin reports the results of potato selection through a series of years. The work was started in 1911 and is still being continued. The results reported show large gains in yield for the good selected progenies.

There is a close similarity between the methods of propagation of the sugar cane and of the potato, both being done by means of cuttings. There is, therefore, no reason to doubt but that similar results will be obtained with sugar cane if the work is carefully done.

The methods of selection used at the Utah Station are identical with those we are using in the selection of sugar cane.

The results reported in the bulletin are briefly abstracted as follows:

After giving a review of the literature Stewart gives the following plan of the experiment:

> "In 1911 a number of the highest-yielding hills, and also of the lowest-yielding hills, were selected from the Majestic, Bangor, and Peerless varieties, then being grown at the Utah Station. Each hill was put in a separate paper bag and numbered. In 1912 the tubers from each hill were cut into sets weighing approximately two or three ounces and containing on the average two eyes. The sets were planted about 15 inches apart with rows three feet apart. The row thus planted from the sets of each hill was marked with a numbered peg and regarded as a unit. No effort was made to keep the sets from each tuber separate from those of other tubers in the same hill.
>
> "At harvest time each hill was dug separately and the tubers placed in a paper bag. During the fall and early winter the tubers from each hill were weighed, counted, and returned to their bag for storage until the data for the progeny-rows were all calculated. The poorer rows in the good selections were all discarded. About half of the best hills from the best progeny-rows and a few high-yielding hills from the other good rows were chosen for planting the next spring. In the poor selections the lowest-yielding hills were used as seed. The same sort

* Bulletin No. 176, by George Stewart.

of selection was continued from 1912 to 1919 and is being further continued and supplemented, except that the poor selections were discarded in 1916."

By the year 1916 all the progenies selected in 1911 had been discarded except one, that of hill No. 25. The strain represented by hill No. 25 was found to be the best, that progeny giving the highest yield, yet in 1911 this particular hill was surpassed by 24 other hills out of 29. This shows the importance of a careful study for several of the different selections so as to determine which ones have the power of transmitting their superior characteristics to their progenies. In this way the different strains in the variety may be separated.

The results of the selections are studied and summarized as follows in the bulletin:

Analysis of Data.

"In Table XII are given the summary data for the pedigree selection Mg 25–1–9–20–3–15 and for the unselected stock for the years in which it was grown as a check, 1915 to 1920, inclusive.

"The pedigree-selected strain produced somewhat more than a hundred bushels higher yield than did the unselected strain, except in the year 1919, when the yield was only 29.6 bushels greater. The yield to the hill was about in the same proportion as the acre-yield, except in the year 1919, when the pedigree strain yielded 358.20 grams to the hill as compared with 270.20 grams for the unselected. With the unselected yield at 117 bushels, the pedigree stock should have yielded 156 bushels, but it made only 147 bushels, due to low yield of the pedigree strain 3–15–10, on which the stand was poor. Attention has already been called to the fact that 1919 was highly unfavorable for potatoes.

TABLE XII.—SUMMARY DATA FOR THE PEDIGREE SELECTION MG 25–1–9–20–3–15 AND FOR THE UNSELECTED STOCK 1915–1920, INCLUSIVE.

Year	Pedigree Selection Mg 25-1-9-20-3-15		Unselected Stock		Gain Over Unselected (bushels)
	Weight to the Hill (grams)	Acre-yield (bushels)	Weight to the Hill (grams)	Acre-yield (bushels)	
1915	1050.91	316.7	643.02	179.3	137.4
1916	839.40	330.7	583.70	191.2	139.5
1917	810.66	382.4	698.39	269.3	113.1
1918	771.57	311.9	580.11	202.4	109.5
1919	358.20	146.9	270.20	117.3	29.6
1920 *	962.12	353.4	517.60	184.8	168.6
Average	789.61	307.0	548.83	190.7	116.3

* At the time of publication only the yields for the 1920 harvest had been obtained. The other data required three or four months for tabulation and calculation.

TABLE XIII.—SUMMARY DATA FOR PEDIGREE STRAIN MG 25-1-9-20-3-15 AND FOR THE UNSELECTED STOCK WITH RESPECT TO NUMBER OF TUBERS TO THE HILL AND THE AVERAGE SIZE OF TUBER, 1915-1919, INCLUSIVE.

Year	Pedigree Selection Mg 25-1-9-20-3-15		Unselected Stock	
	Average No. Tubers to the Hill	Average Weight to the Tuber (grams)	Average No. Tubers to the Hill	Average Weight to the Tuber (grams)
1915	5.84	182.11	4.48	143.56
1916	4.58	184.20	3.84	152.80
1917	5.22	153.39	4.50	151.63
1918	4.10	187.43	4.49	127.87
1919	3.83	112.38	3.26	82.83
Average	4.89	163.90	4.14	131.74

"The number of tubers to the hill is greater and the average size of tubers is larger in the pedigree strain than in the unselected. Table XIII, which contains a summary of these data shows that there is an appreciable difference in these two respects.

"There is an increase in the average number of tubers to the hill from 4.14 to 4.89 in favor of the pedigree strain, or 18.1 per cent. In average size of tuber there is an increase from 131.74 grams for the unselected to 163.90 grams for the pedigree strain,—a gain in size of 24.4 per cent. Both of these increases are desirable.

"As a six-year average, from 1915 to 1920, inclusive, there is a gain in acre-yield of 60.9 per cent, and a further gain of 24.4 per cent in average size of tuber. Although the percentage of marketable tubers was not recorded throughout the experiment, it seems safe to conclude that an increase of 24.4 per cent in size of tuber means an appreciable gain in percentage of marketable tubers. The last two years, the only ones in which the percentage of the marketable tubers was obtained, show 78.6 per cent marketable for unselected stock and 90.5 per cent for the pedigree-selected strain, a gain of 11.9 per cent for the selected strain.

Discussion of Results.

"*Merely to select high-yielding hills has not been effective in this experiment, because many such hills have produced progeny rows of only mediocre quality. Early in the experiment it was found necessary to test the power of selected hills to transmit their quality to the next generation.*[1] A good hill may have become such not because of any inherent virtue in itself, but because of having had more favorable surroundings, such as more fertile soil, more moisture, or more room in which to grow.

[1] The italics are ours and were used to indicate what we regard as essential to the success of work of this kind.

"J. Arthur Harris[2] of the Carnegie Institution has marshalled many data that show even the most uniform soils to be highly variable. F. S. Harris[3] of the Utah Station demonstrated that both too little and too much moisture in the soil produced lower yields of potatoes than the more favorable medium degree of wetness. Stewart[4] found that missed hills gave an appreciable advantage to both adjacent hills. In this experiment, with hills planted 15 inches apart, one missed hill increased the yield of each neighbor 23.2 per cent, or 46.4 per cent for the two. From the above, it is apparent that one potato hill may far outyield a neighboring hill owing to some environmental advantage. Because selection of such a hill is made on purely *somatic* characters, that is, body characters that are visible, it is not possible to predict the extent of transmission of the selected quality to its offspring.

"On the other hand, when the selection can be so made as to select for an inherent quality, that is, for a *gametic* character, then a fair degree of transmission may be expected. So far as the nature of material permitted, this was the type of selection that has been followed during the experiment here reported. To accomplish this, it was necessary to delay selection until the second year, or even until later years, in order to tell whether a given potato mother-hill had the power to transmit its yielding power to the daughter-hills and thereby leave its imprint on the race. Such plant-breeding is not far removed from the problem a cattle breeder is attempting to solve when he chooses a sire for his herd.

"In the beginning, when the three varieties were being tested, Bangor and Peerless were not discarded at once, but were carried three years in order to make sure that the Majestic had not produced a higher yield merely on account of some environmental advantage. The 1913 crop showed a considerably higher yield for hill Mg 25 than for any other progeny. It was only after this test that the other strains were discarded. In fact, had not transmission tests been used this hill would have been discarded two seasons previously, because in 1911 it was surpassed in yield by 24 other hills out of a total of 29. The history of this hill illustrates both sides of transmission: (1) a hill ranking only twenty-fifth in 1911 gave progeny in 1912 that was better than any other; (2) in 1913 it was again tested against two others of the best progenies and again produced the highest yield. It was, therefore, concluded that here was a strain that carried at least some inherent high-yielding qualities. When the 1915 harvest permitted, for the first time, a comparison with the unselected bulk strain of the same stock the yield was 301 bushels as compared with 179 bushels for the unselected.

"The 1919 harvest may have given cause to question the superiority of the selected strain, for after showing an increased yield of about a hundred bushels for four years, the selected progeny suddenly relapsed to a yield of only 29.6 bushels greater than that of the unselected strain, but this was a gain of 25.2 per cent. During 1920, there was a decidedly better stand, an earlier start, a thriftier growth, and greater freedom from disease in the selected stock. In every way the pedigreed strain promised to be much better. The gross acre-

[2] Jour. Agr. Rsch., Vol. 19, No. 7, pp. 279–314.

[3] Utah Exp. Sta. Bul. No. 156.

[4] New York (Geneva) Exp. Sta. Bul. No. 459, pp. 45–69.

yield was 353.4 bushels as compared with 184.8 bushels for the unselected stock, overturning completely the 1919 result and bearing out the results of former years, namely, that the pedigreed strain was greatly superior to the unselected stock of the same variety when grown under the same conditions.

"The poor yields obtained from the "mixed" and " general" stocks show that remnants of even selected stock are not good for seed after the best hills or best strains are taken out.

"In the degenerate strains that formed part of the experiment until 1916 there was much disease, particularly Rhizoctonia. It is probable that there were present also the diseases of degeneration, such as curly dwarf, leaf-roll, spindling sprout, and mosaic studied by Stewart [5] in New York and reported by Whipple [6] in Montana. Degeneration, however, does not seem to be always due to disease, at least to any now recognized, for among the foliage selections is a strain (Mg 25–1–9–20–3–19) selected in 1917 for chlorosis to the extent of more than half the leaf-area. Another strain showed about one-fifth of the leaf-area to be chlorotic. These two strains have continued to breed true, the plants bearing leaves that are chlorotic to about the extent of one-half and one-fifth the leaf-areas, respectively. Other chlorotic selections failed to breed true. During 1920 M. Shapavolov, potato pathologist for the U. S. Department of Agriculture, kindly examined these strains for disease. He could not recognize any disease. Either there must be degeneration without disease, or some disease not yet segregated from the others. Possibly there may be a chlorotic condition other than mosaic, or hiding mosaic, that should take rank with curly dwarf and mosaic.

Summary.

"In 1911 high-yielding and low-yielding hills were selected from three potato varieties—Bangor, Peerless, and Majestic. These hills were planted in individual progeny rows and so harvested as to keep each hill separate. Similar selection was continued until 1914, when Bangor and Peerless stocks were discarded on account of inferiority in yield of both these varieties to Majestic. Good and poor selections were made from this variety until 1916, but thereafter until the present the only selections made were for high yield, with the exception of a few strains that developed unusual foliage characters.

"The experiment was so conducted as to avoid selection for somatic characters and to secure selection for gametic qualities. This was done by growing all of the best strains for two or more years in order to get a progeny test of the power of a strain to transmit its desirable qualities to the succeeding generations. In no important cases were selections made on the results of one season; usually three to five years were regarded as necessary to show whether a strain should be selected or discarded.

"By 1915 the high-yielding strains yielded an average of 301.03 bushels to the acre as compared with 179.30 bushels to the acre for unselected. From 1915 to 1920 the selected strain has out-yielded the unselected stock of the same variety by more than a hundred bushels an acre, except in 1919, when there

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[5] New York (Geneva) Exp. Sta. Bul. No. 422, pp. 319–357.

[6] Montana Exp. Sta. Bul. No. 130, pp. 3–29.

was a difference of only 29.6 bushels. Possibly the extremely unfavorable growing season of 1919 may have caused this wide fluctuation. At any rate, the superiority of the selected strains manifested itself again in 1920, out-yielding the unselected strain by 168.6 bushels.

"Not only were the acre-yields of selected strains higher than those of unselected stock, but there were more tubers to the hill; the individual tubers were larger; and, as a consequence, there was a higher percentage of marketable potatoes than in the unselected stock.

"As a six-year average, 1915–1920, the acre-yield of the selected strain was 60.9 per cent greater than that of the unselected, and the average size of tuber 24.4 per cent greater than that of the unselected. Remnant hills and strains, after the best had been selected out for seed, gave somewhat poorer yields than did unselected stock.

"The germination of the selected strain is more rapid, the stand is better, the growth thriftier, and diseases less apparent than for the unselected potatoes of the same variety.

"A degenerate strain of highly chlorotic foliage has been isolated. A potato pathologist could recognize no known disease on the strain."

[J. A. V.]

Phosphoric Acid at Paauhau.

Paauhau Experiment No. 12, 1919 and 1921 Crop.

This was a test to determine the value of phosphoric acid on acid soils in Hamakua. The experiment has been carried on through two crops, one plant and one ratoon. The cane was Yellow Caledonia. Reverted phosphate was applied at the rate of 0, 750, and 1500 pounds per acre. It was placed in the furrow by hand before planting and well mixed with the soil.

Phosphate was applied to the plant crop only. The 1921 crop was fertilized entirely with nitrate of soda.

In addition to the reverted phosphate all plots received a uniform application of nitrate of soda, 1100 pounds for the first crop and 1000 for the second.

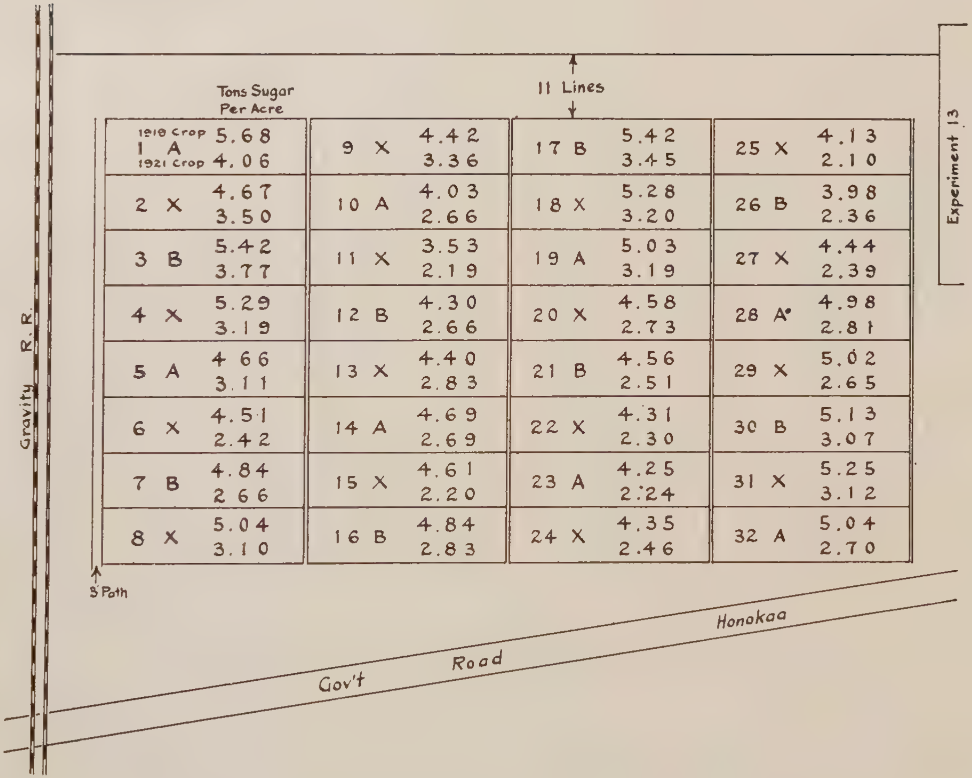
The results of the harvests are as follows:

Plots	Treatment	Tons per Acre			
		Cane		Sugar	
		1919	1921	1919	1921
X	No reverted phosphate	36.9	4.61	25.8	2.73
A	750 lbs. reverted phosphate	38.8	4.79	27.8	2.93
B	1500 lbs. reverted phosphate	38.7	4.81	27.4	2.91

Reverted Phosphate Experiment.

Paauhau Sugar Plantation Co. Exp. 12, 1919 & 1921 Crops

Field 3

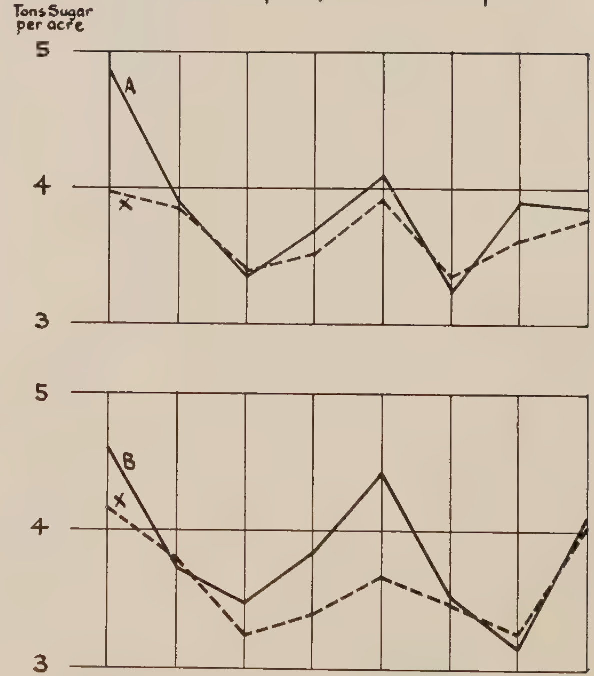


Tons Sugar Per Acre (upper figure 1919 Crop, lower figure 1921 Crop)

Plot	1919 Crop	1921 Crop	Plot	1919 Crop	1921 Crop	Plot	1919 Crop	1921 Crop	Plot	1919 Crop	1921 Crop
1 A	5.68	4.06	9 X	4.42	3.36	17 B	5.42	3.45	25 X	4.13	2.10
2 X	4.67	3.50	10 A	4.03	2.66	18 X	5.28	3.20	26 B	3.98	2.36
3 B	5.42	3.77	11 X	3.53	2.19	19 A	5.03	3.19	27 X	4.44	2.39
4 X	5.29	3.19	12 B	4.30	2.66	20 X	4.58	2.73	28 A*	4.98	2.81
5 A	4 66	3.11	13 X	4.40	2.83	21 B	4.56	2.51	29 X	5.02	2.65
6 X	4.51	2.42	14 A	4.69	2.69	22 X	4.31	2.30	30 B	5.13	3.07
7 B	4.84	2 66	15 X	4.61	2.20	23 A	4.25	2.24	31 X	5.25	3.12
8 X	5.04	3.10	16 B	4.84	2.83	24 X	4.35	2.46	32 A	5.04	2.70

Curves Comparing Average Yields For Two Crops, With & Without Phosphoric Acid.

Paauhau Exp. 12, 1919 & 1921 Crops



A plots 750# Reverted Phosphate per acre.
B plots 1500# Reverted Phosphate per acre.
X plots No Reverted Phosphate.
Phosphate applied to plant crop only.

The gains from the phosphate applications were the same for both crops and amounted to about two tons of cane and 0.2 ton of sugar per acre. This gain is small, but it is fairly consistent as shown by the curves of plot yields shown on page 31. That the phosphate needs of these soils are not very great is further shown by the fact that 750 pounds of reverted phosphate supplied all the P_2O_5 wanted for at least two crops (see table giving yields of A and B plots).

Under conditions such as the above all the phosphoric acid needed will be supplied by the mixed fertilizers now being used on the plantation.

This field is now being plowed and the experiment will be discontinued and replaced by one testing the value of potash.

DETAILS OF EXPERIMENT.

Object:

To determine the value of reverted phosphate on acid soils in the Hamakua district.

Location:

Paauhau Sugar Company, Field 3.

Crop:

Yellow Caledonia, plant and 1st ratoon.

Layout:

Thirty-two plots, each ¼ acre, consisting of 10 lines, 5 ft. wide and 217.8 ft. long.

Plan:

FERTILIZER—POUNDS PER ACRE.

Plots	No. of Plots	Treatment	
		1919 Crop	1921 Crop
X	16	No reverted phos.* and 1100 lbs. Nit. Soda......	1000 lbs. Nit. Soda
A	8	750 lbs. reverted phos. and 1100 lbs. Nit. Soda...	“ “ “ “
B	8	1500 lbs. reverted phos. and 1100 lbs. Nit. Soda..	“ “ “ “

* Reverted phosphate applied in furrow before planting and well mixed with soil.

In harvesting the cane was flumed into cars and weighed. Each car was sampled at the mill and the juices averaged for each treatment.

J. A. V.

The Selection of Rubber Trees According to Individual Differences in Yield.*

I—These are the results of a series of observations made in the Federated Malay States on the specific differences in the amount of rubber yielded by individual trees of *Hevea brasiliensis* of the same age and growing under the same conditions, in order to establish also whether there exists a correlation between

* International Review of the Science and Practice of Agriculture, Vol. XI, pp. 184–185. 1920.

the yield and the girth of the trunk. Some 1000 trees, 7 years old, in a normal plantation covering 13 acres, were carefully studied, the trees being in their third year of tapping.

Great variations were found in the rubber content of the latex (the "strength" of the latex) from different trees, and appeared to be constant from year to year. Some trees yielded 23 gm. of rubber per 100 c.c. of latex, others as much as 54 to 55 gm. per 100 c.c. of latex, the mean of the 245 trees examined being 39.58 gm. per 100 c.c.

The rubber content of the latex increases as the trees grow older, to the extent of ½ per cent per annum.

The author admits the possibility of obtaining good positive results from selection based entirely on individual variations; if high-yielding trees can be segregated and provided that pollen of poor-yielding trees can be prevented from gaining access to the flowers, it should be possible to get seeds capable of producing trees with a high percentage of rubber in the latex. There is a definite correlation between girth and yield, but it is not sufficiently well indicated to be of great value in eliminating trees from a plantation.

II—In Hevea plantations there are good and bad yielding trees. For 5000 trees 8–9 years old, the mean daily yield of latex was 22 c.c. Eighty per cent of these trees gave on the average ± 10 c.c., while the remaining 20% alone produced 65% of the entire yield. It is to be inferred from these results that productivity is a hereditary character.

On the other hand, in plantations, free cross-pollination mixes good and bad elements in the most varied of genetic combinations, while complete segregation of the best specimens involves very great difficulty from the technical and practical point of view.

The author urges the suitability of vegetative propagation of the best yielding trees, by grafting on to the young plants slips from specimens that have been under careful and continuous control and are notable for their high yielding properties.

It is a case of repeating with *Hevea brasiliensis* that which is being tried at present with coffee and cacao in Suriman and has already been carried out on a large scale in the United States citrus plantations. [W. W. G. M.]

The Single-Sheet Lap-Seam Boiler.

By J. P. Morrison.[1]

It is probable that no question of machine design has received more careful and intelligent consideration than has the design of the shell seams of steam boilers. Fairbairn's tests were conducted in 1838. W. Bertram conducted tests at the Woolrich Dock Yards in 1860. D. K. Clark discussed riveted seams in 1877. A lap-seam crack was reported in *The Locomotive,* issued in April, 1880,

* Chief inspector, Hartford Steam Boiler Insurance and Inspection Company.

while that publication dealt at considerable length with the stresses occurring in lap seams. On April 17, 1891, J. M. Allen, who was then president of the Hartford Steam Boiler Inspection and Insurance Co., delivered a lecture at Sibley College, in which he gave a complete diagnosis of the various joints then in use, having particular reference to the triple-riveted butt-strap joint. This lecture was published and widely distributed, and the principles set forth are those upon which the calculations of riveted joints, encountered in modern practice, are based. In the early days of steel-plate manufacture the product was confined to sheets of small dimensions. As a consequence the boilers built in those days were composed of a number of courses, and each course, if the boiler was unusually large, would be made up of several sheets. It was not uncommon to encounter a boiler 14 ft. in length and 48 in. in diameter made up of seven courses formed of four sheets each. But as the steel makers became able to produce larger plates, boilers were constructed of a lesser number of courses, each composed of fewer sheets. This appeared to be of considerable advantage in many ways, and when it became possible to produce plates of such size that only two were needed to form the shell plates of a boiler, they found a ready market. With the development in steel manufacturing the importance of the physical and chemical properties of the boiler plates was recognized, particular emphasis being placed on the advantages of great ductility even when obtained at a loss in ultimate tensile strength. Laminations found in steel plate had elicited some criticism, and there was a loud protest at the practice of some steel makers of shipping unbranded plates, for the boiler makers were beginning to realize the necessity of having the steel maker's brand appear on each sheet of the finished boiler. Boiler plates manufactured by both the open-harth and bessemer processes were used, and it was understood that the quality of the boiler plate depended more upon the grade of raw materials than upon the particular procss.

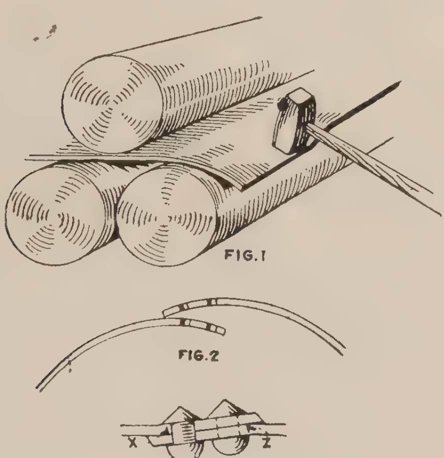


Fig. 1. Forming end of plate over roll.
Fig. 2. Ends of plate to be sledged to shape.
Fig. 3. Lap seam stressed to failure.

Difficulty that had been experienced by reason of girth-seam leakage, fire cracks and mud burns, all attributed to the sediment within the boiler accumulating against the girth-seam laps, gave added attraction to the idea of rolling one sheet to form the bottom half of the boiler. The upper half continued in some cases to be constructed of two or three plates, while in other cases one large plate only was used. This form of construction necessitated the use of a longitudinal seam on each side of the boiler extending from head to head, and was confined to shops having plate-bending rolls of sufficient length to pass a 16-ft. or 18-ft. sheet between housings.

It is worthy of note that this construction was criticized twenty-five or more

years ago, and subsequent developments have proved the correctness of those who, while without sufficient facts at hand to justify outright condemnation of the single-sheet boiler, brought its weaknesses to public attention and withheld approval, citing the explosion of one boiler due to the single bottom sheet construction, and which resulted in the loss of two lives and an estimated property damage of $5,000. Those unacquainted with shop practice of the older days will hardly realize the possible damage done to a sheet during the process of fabrication of the boiler. The rivet holes were punched full size, except where special requirements were to be met, so the mill cracks started by the punching process were not removed. Few of the shops were equipped with a press to shape the

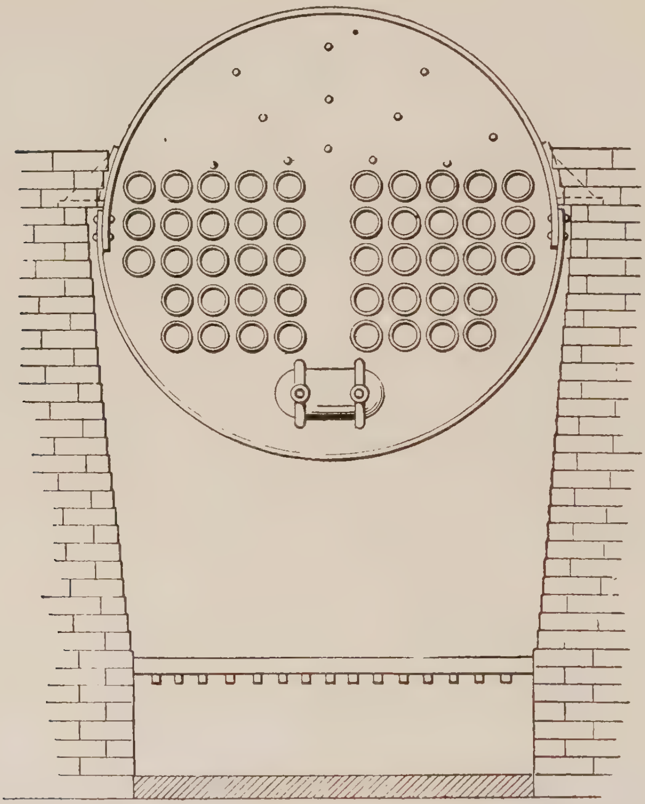


Fig. 4. Seams of single-sheet boiler inaccessible and exposed to furnace heat.

ends of the sheet to the proper curvature. The work was done by placing the sheet over a rail or one of the bending rolls and sledging the edges, often stressing the questionable material beyond its elastic limit along the line of rivet holes in the second row, where the sheet had already been weakened by the reduction of the metal and by mill cracks, due to punching the rivet holes. To this were added the stresses set up when the poorly fitting joint was bolted up and later riveted. Usually, the joint was then sledged into shape for calking.

Fig. 1 indicates the change in shape of the ends of a plate when being formed over the roll by the use of the sledge. Fig. 2 illustrates the condition of the ends

of the plate, after the rest of the plate has been rolled to the proper curvature. The ends, having been shaped by blows of the sledge, do not conform to the true curvature. That was also the era of the drift pin, when an unfair hole could be made fair, adding more stresses to the sheet along the line of rivet holes.

Even then the trend of the times was towards boilers of larger diameter. Since the size of the plates obtainable would not permit locating the head-to-head seams above the horizontal diameter, the seams of such a boiler were exposed to furnace temperatures, in addition to the stresses due to difference in temperature of the upper and the lower section of the boiler, the former being exposed to the atmosphere, while the latter was subjected to furnace head as indicated in Fig. 4. The intensity of these stresses would vary considerably, but one authority has reported them as amounting to approximately 6,000 lb. per square inch.

The never-ending effort of the contained pressure to perform the impossible feat of rounding out the irregular surface existing at the lap seams produces the lap-seam crack, for which this joint is notorious. In Fig. 3 x and z indicate the development of such a crack, while Fig. 5 shows a crack that developed in a plate in service. Furthermore, this lack of symmetry renders the plate along the line of greatest stresses susceptible to corrosive action, which would be intensified where there were three pairs of supporting brackets, as was the case with large boilers; and the settling of the furnace walls at the front or rear transferred the load, amounting to one-half the weight of the boiler and contents, onto the center bracket.

The strengthening effect of the girth seam has been the subject of considerable discussion. It is in principle quite the same as applying a hoop to the circumference of the boiler. This is evidenced in a number of instances when, upon the vessel being stressed beyond the elastic limit, the increase in circumference did not even extend to the girth seam, owing to the hoop effect of the seam. The fact that the explosion of a two- or three-course boiler, due to lap-seam failure, rarely results in a rupture extending across a girth seam should leave no need of further arguments in favor of a construction embodying girth seams.

Before the double-strapped butt joint was universally adopted, a large number of lap-seam boilers, many of them of the single-sheet variety, were placed in operation. The majority of these boilers were intended for 100 lb. pressure, using a factor of safety of 4. This factor has been generally recognized as inadequate, even for boilers of superior construction, and could not be expected to be continued as satisfactory for lap-seam boilers after a few years of service and abuse.

After considering the various factors having a direct influence on the safety of single-sheet boilers, it does not appear strange there have been so many violent explosions, with the loss of numerous lives and property damage approximating a million dollars in value. The facilities for investigating boiler explosions were probably not in keeping with the general industrial activities, but in the early days, when 80 to 100 lb. pressure was considered high, each explosion was more or less shrouded in mystery, and the theories advanced as to the cause were about as intricate and vague as could be imagined. The presence of a

super-gas, the spheroidal state of the water, the geyser action of the water, superheated water, low water or no water, inflammable steam and the presence of a vacuum were theories, each of which had its following. The cause of the difficulty, the single-sheet lap-seam crack, was generally overlooked by investigators seeking to establish the correctness of their pet theory as to the force, or phenomena causing the destruction. A few engineers realized the influence of manufacture on boiler safety. Zera Colburn is quoted as stating in 1880, "All our knowledge of boiler explosions goes to show that in the majority of cases the actual explosion results from some defect, either original or produced, and either visible or concealed, in the material, workmanship or construction of the boiler."

There is no complete list of explosions of single-sheet boilers nor of the number that have been found to be unsafe and discarded from service, but the record available is sufficient to indicate clearly the unusual hazard attending the operation of boilers of that description. The condemnation of a boiler having a seam crack 14 ft. in length was recorded in 1894, and on February 1, 1895, a boiler 66 in. in diameter by 16 ft. long, containing 54 four-inch tubes, and constructed of steel plates 3/8 in. thick, forming a single course of the bottom of the boiler and three courses of the top, exploded in an electric light plant with disastrous results. One man is reported to have been killed, three others seriously injured, and the power plant totally wrecked. The line of failure followed the seam from the head two-thirds of the length of the boiler, from which point separation occurred, the girth seam being followed across the top

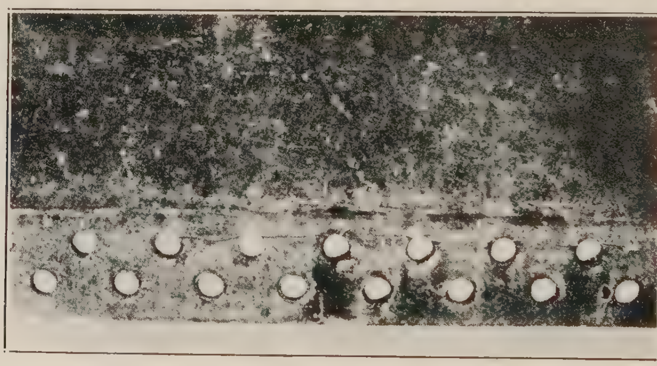


Fig. 5. A lap-joint crack.

of the boiler by one branch of the crack, and the other extending through the solid plate downward toward the rear. The boiler had three pairs of supporting lugs, and conditions indicated that the initial failure occurred under the middle lug.

The Rochester, N. Y., Brewery explosion followed in 1899, and caused the death of one man, as well as property damage estimated at $25,000. On November 26, 1901, a disastrous explosion of a 66-in. by 16-ft. boiler at the plant of the Penberthy Injector Works, Detroit, Mich., demolished a three-story brick building and cost the lives of thirty and seriously injured thirty-five others.

The total property damage was estimated at $100,000. This boiler had seen but six or seven years of service and was understood to be in good condition. The line of failure followed the longitudinal seam on one side of the shell, substantially in a straight line from one head to the other.

Of a single-sheet boiler the next violent explosion of which record is available, occurred at the plant of the American Tin Plate Co., Canton, Ohio, on May 11, 1910, and was reviewed in the issue of *Power* of May 31 of that year. Then followed the Midvale, Ohio, explosion and the Shelton, Conn., explosion in 1911; the Pleasant Valley, Conn., explosion in 1915; the Athol, Md., explosion in 1916, and the Cross Run, Pa., explosion in 1917; all bearing the earmarks of lap-seam defects and occurring to single-sheet boilers, taking the usual toll in life and damaged property.

While the Fargo, Tex., explosion, occurring on October 1, 1914, was caused by a lap-joint failure of a single-sheet boiler, it differed materially from some of those previously mentioned, inasmuch as the boiler had been carefully ex-

Fig. 6. Result from the explosion of a single-sheet boiler.

amined by an expert inspector and pronounced unsafe to operate, his opinion being based on the corrosion which had attacked the longitudinal seam. These seams were not visible on account of their location below the upper tubes, but after cleaning those parts as thoroughly as possible, the inspector determined by his finger tips that there had been so much reduction in thickness that there was not sufficient strength to withstand the pressure. However, the owner placed the boiler in operation, and the second day thereafter it exploded, killing two men, injuring two others and wrecking the plant. Investigation developed the fact that the rupture had occurred in the outer sheet of the lap, that sheet forming the bottom half of the boiler, as is common with single-sheet construction, and followed a line parallel to the edge of the inner lap, extending from head to head through metal which, owing to corrosion, did not average $\frac{1}{8}$ in. in thickness.

The accompanying photographs, Figs. 6 to 8, illustrate the damage done by the explosion of a single-sheet boiler, which resulted in the death of two work-

men, the serious injury of two others, and the total destruction of the plant. Fig. 6 gives a good idea of the general damage to the plant, and Fig. 7 is a close-up view of the boiler tubes and head. The boiler was said to have been 24 years old, and its builder was unknown, as it had been used elsewhere and had changed owners a number of times. So far as could be learned, the boiler had never been subjected to an examination by anyone qualified to pass judgment in such matters. The double-riveted lap seams extended from the front head to the rear head on each side of the boiler. The means of support consisted of three pairs of cast-iron brackets resting on the furnace walls, one being between the dome and longitudinal seams, on either side of the boiler. The pressure carried at the time of the explosion was 100 lb., and it was probable the builder sold the boiler when new with the customary guarantee of that pressure, which would be permitted by a factor of safety of 4.

Some time previous to the accident leakage was observed at the longitudinal seam under one of the center support brackets. A boilermaker of questionable ability and experience patched the seam as indicated by the arrow in

Fig. 7. Close-up view of boiler tubes and head.

Fig. 8, apparently without giving thought to the cause of the difficulty, but riveting the patch at the boiler seam and using patch bolts for securing the new seam. The boiler was continued in operation without further trouble until about a week before the explosion, when seam leakage was again observed. The mill superintendent and an employee are said to have drilled and threaded for ¾-in. capscrews, four holes along the seam where leakage had appeared. A soft patch consisting of a sheet of plow steel and a thin sheet of lead was secured to the boiler by means of capscrews and nuts, and the boiler was again placed in service.

The failure occurred in the sheet forming the lower part of the boiler, on a line coinciding with the edge of the inner lap, just about the same location as in the failure of the Fargo, Tex., boiler, and did not follow nor enter the rivet holes. It extended the entire length of the seam, as is customary with violent failure of this kind. The rivets in the head seams either sheared at the junction

of the plates or the rivet heads pulled off, as none of the rivet holes were destroyed, although some of them were found to be considerably elongated.

After an accident, where there are so many possible causes, it is difficult to define responsibility. In this case the center bracket above the point where the initial leakage and crack developed, most likely supported the entire weight of that side of the boiler, which, as has been outlined, would follow from the settling of the furnace at the front or back bracket, and would clearly justify the modern requirements which provide for four-point suspension only. The factor of safety was not one-half as great as considered necessary by good authorities for boilers of such great age and design, and had a proper factor of safety been maintained, the explosion would not have occurred, as the pressure permitted then would not have been sufficient to operate the plant, and the boiler would have been scrapped.

Had the service of the boiler been limited to ten years, as has been advocated for the lap-seam boiler, its use would have been abandoned years before.

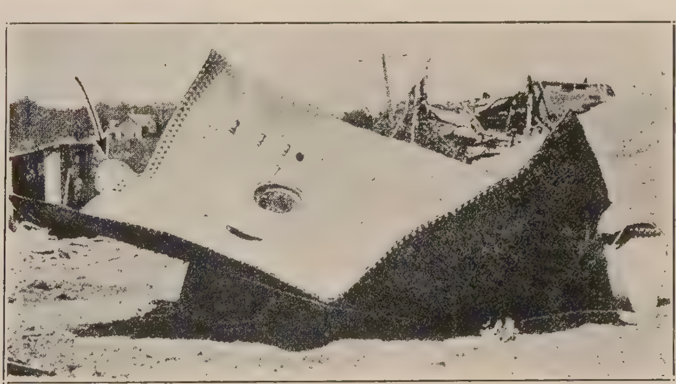


Fig. 8. Shell plates blown free of the ends and tubes.

The owner no doubt would have experienced some financial loss, but nothing compared to the loss resulting from the explosion. Had the boilermaker who patched the boiler been acquainted with developments of recent years, so far as boiler design and safety are concerned, and the rules which prohibit repairing a boiler in which a lap-seam crack has developed, or had the mill superintendent realized the clear danger warnings and discontinued the boiler from service until the advice of competent persons could be obtained, there would have been no explosion. This accident emphasizes the difficulty of obtaining proper co-operation of boiler owners in enforcing reasonable rules and regulations, as the boiler was being operated without a certificate from the state authorities, who had no knowledge of its existence, and it is doubtful if the owner and those in charge of its operation knew that the boiler differed in any material way from new boilers of modern design.

Fortunately, the installation of new boilers of this description is prohibited in many states and cities, so its manufacture practically has been abandoned, but there are a great number in operation, and the next few years may witness an increasing number of failures, as the defects, undoubtedly existing, develop until

rupture takes place. An increase in the factor of safety will result in a reduction of pressure; this may cause the removal of the boiler from its present place of operation, to be disposed of, if there are no restrictions, through dealers in second-hand boilers, only to be placed again in service, to the jeopardy of someone's life and property.

In discussing the Cross Run, Pa., explosion, *The Locomotive*, in the July, 1917, issue, asserts: "The lap-seam boiler has been a fruitful source of steam-boiler accidents in this country, and of lap-seam boilers perhaps no class has been more subject to disaster than those made in a single course with two sheets, one above and one below." It is evident that the single-sheet boiler "has been weighed in the balance and found wanting." It has sustained injuries during the process of fabrication, is impossible of thorough inspection, has been stressed beyond its safe limit by temperature difference, by continual flexture due to non-conformity to a true circle, by lack of girth-seam support, and by the unequal distribution of the weight of the boiler, contents and connections.

Shall those boilers now in use be continued in service, to change owners and operating conditions at will, until each gives positive and direct evidence of its worthlessness by exploding, with the aggregate loss of another hundred of lives, and of another million-dollar property damage? Or shall the rule against habitual criminals be invoked, and each boiler of that type sentenced permanently to the scrap yard, where it will have no further opportunity to destroy, just as the police character, in whom the bad outweighs the good, is given an indeterminate prison sentence, so he can do no more injury to society? If those financially responsible for the continued operation of single-sheet boilers could be made to realize that immediately preceding each lap-seam boiler accident the owner considered his boiler perfectly safe to operate; or appreciated the fact that under certain circumstances any person might be the victim, as our sidewalk basement boiler rooms, hotel power plants and department store power plants, if they do not contain unquestionably safe equipment, place the lives of all in jeopardy; or realized that defective boilers endanger the lives of the employees to whom the employer owes the moral responsibility of furnishing safe tools—then there is no question that the verdict would be, "The single-sheet boiler must go." [W. E. S.]

The Position of the Seeds in the Soil at the Time of Sowing.*

I—Results of experiments comparing the method of planting sugar cane setts of one eye-bud placed upwards with other improved methods, especially with the method of setts of three eye-buds pointed sideways.

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* International Review of the Science and Practice of Agriculture, Vol. XI, pp. 332–333. 1920. (Experiments in India.)

Owing to special conditions of soil and water the Brix reading of the juice scarcely exceeded 14% in the different methods of cultivation. Hence the table given below (which compared the results given respectively by: (A) Setts of one eye-bud pointed upwards; (B) setts of three eye-buds pointed sideways) indicates only the yield in cane and not the yield of "gur" (crude sugar).

RESULTS OF COMPARATIVE EXPERIMENTS OF PLANTATION.

Method of planting	Number of eyes planted	No. of plants germinated after 20 days of planting	Percentage of germination	No. of plants finally kept (mother and tiller plants)	Number of canes harvested	Weight of canes harvested	Average weight of one cane
I.—Plot of I "guntha" (1/40th of an acre):						lbs.	lbs.
(A) Single eye-bud, point upwards	901	833	82	1079	843	4325	——
(B) Three eye-buds points sideways	1002	511	50	889	782	3366	——
II.—Plot of 30 "gunthas" (¾ of an acre):							
(A) Single eye-bud, point upwards	27030	24990	82	32370	25290	129750	5.1
(B) Three eye-buds points sideways	30060	15330	50	26670	23460	100980	4.3

The Brix reading being only 14.2% in both methods of planting, the yield in "gur" obtained for 30 *gunthas* was:

(A) Single eye-bud, point upwards .... 12,570 lbs.
(B) Three eye-buds, points sideways .... 9,660 "

If the Brix reading had been 18 to 19%, as is usually the case for sugar cane, the yield in "gur" would have been:

(A) Single eye-bud, point upwards .... 16,350 lbs.
(B) Three eye-buds, points sideways .... 12,725 "

These figures show that the yield of cane was about 25% higher with method (A) than with method (B). Further experiments on a larger scale are being carried out on the Canal Farm at Gokak.

There are, however, certain disadvantages in the method of planting single eye-buds, point upwards. The setts being too small and exposed on both sides close to the bud, the plants developed from them, though they take more quickly than those developed from setts with three eye-buds, points sideways, look somewhat unhealthy during the first month until a small dose of ammonium sulphate is given as a top-dressing; but after that top-dressing the plants (A) grow as luxuriantly as plants (B).

The following year a fresh experiment was made: Setts with three eye-buds were taken and the middle eye-bud was removed; the sett was then planted with the two remaining eye-buds upwards. It is expected in this way to obtain

a better yield than with the single eye-bud point upwards method of the previous year, owing to the elimination of the defects of the single eye-bud method while retaining the advantage of position of the eyebuds point upwards.

II—In view of these results, the author investigated the effect which the position of the seed in the soil at the time of sowing might have on the yield of various plants.

Experiments with maize, leguminous plants and cotton showed that when the seed is planted with the point downwards or sideways, the resulting plants are better than when the seed is planted point upwards.

The position of the seed in the soil at the time of sowing is one of the numerous causes of the unevenness in plants and crops, and even of the non-germination of good seed. But in practice it is only possible to plant the seeds in the proper position when planting is done by hand.

[W. W. G. M.]

Power Cultivation of Sugar Cane.*

By Arthur H. Rosenfeld.

In the report of the Committee on Agricultural Machinery and Implements of the Hawaiian Sugar Planters' Association for the year ended September 30th, 1919, we find the following remarks in a letter to Mr. Lidgate, the Chairman of the Committee, from Mr. David Forbes, the manager of the Waiakea Mill Co., in regard to the possibilities of motor cultivation of cane:

"It is the writer's belief that at no distant date tractors will be on the market of lighter build adapted to such work as cultivation of cane rows and destruction of weeds, or in fact any sort of work where a mule, or mules, can now be used for cane cultivation. It takes no great stretch of imagination to look forward to such machinery and implements of agriculture being used more extensively and propelled by home-made fuel produced from our waste molasses."

The writer of these lines can assure Mr. Forbes that such mental anticipations indeed needed no great stretch of imagination, since, when that letter was written, he had already carried to a successful conclusion the preliminary experiments which led to a complete realization of all of Mr. Forbes' predictions and the adoption of light tractors propelled by alcohol made from our waste molasses in the regular routine of our cultural operations.

The use of heavy and even of light tractors for the preparation of the soil, working of roads, hauling, etc., has been too clearly and definitely demonstrated all over the world to be a success to warrant a discussion in these pages, but the author at least has been unable to encounter records of successful and eco-

* From The International Sugar Journal, Vol. XXII, No. 261.

nomical *cultivation* between the cane rows with tractors as the motive force.

Many light tractors have been on the market for years—the Fiat, Fordson, International, Titan, Avery, Cletrac, and Bates among a host of others—but little attention seems to have been given to the development of machinery to be drawn behind the "steel mules" in the actual routine cultivation operations of a cane field.

The writer has had this problem in mind for several years—in fact when the huge plantations of Santa Ana and Lules were entirely renovated in 1916 and 1917 with new verieties of cane under his direction, the rows in the fields were all laid out in as continuous straight lines as possible and the headlands and irrigation and drainage ditches arranged with the view of interfering just as little as possible with long pulls and few turns. Probably few cultivation

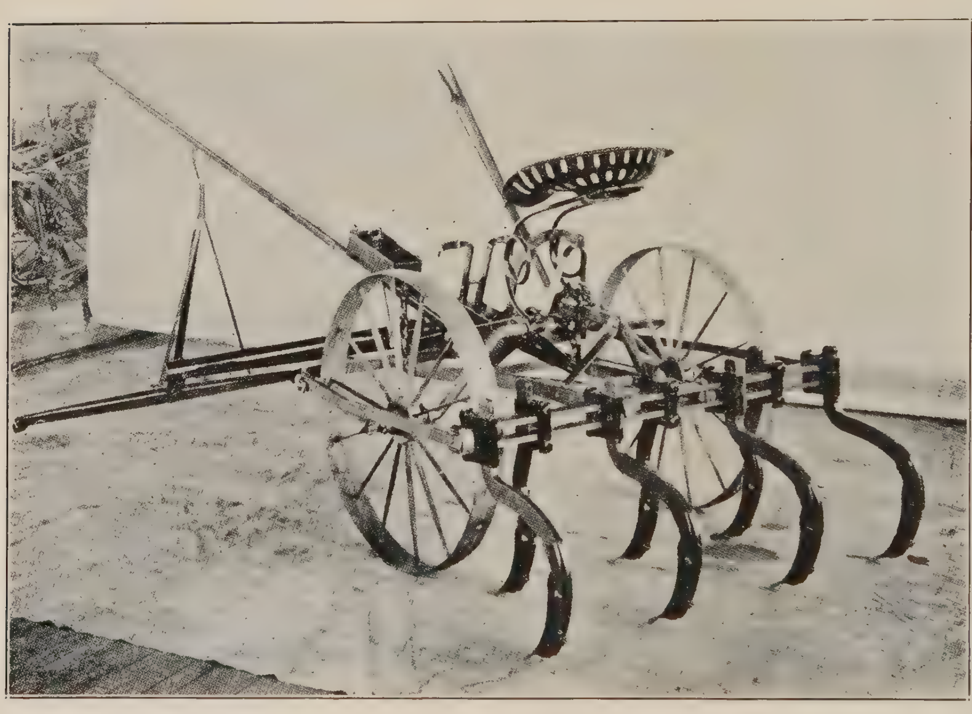
Some of the Motors with various Implements.

managers realize the enormous waste of time and the great amount of wear and tear on the machinery incident to the cultivation of short rows even with mules or bulls, and this loss is all the more accentuated in motor cultivation. The object of the writer has been to so design his plantations as to avoid turns more than every half-mile or so, and this arrangement has contributed in no small degree to the financial success of our tractor trials.

The lack of available machinery for sugar cane cultivation with tractors was the most serious drawback to making the trials, which were not begun until we had definitely proved the feasibility of running on alcohol, since the cost of imported motor spirit or kerosene is prohibitive and the use of a combustible made from a waste product of the industry is a decided stimulus to the use of motors in cane cultivation. It may be mentioned here that denatured alcohol, made on the place and denatured under fiscal supervision, costs us about 8d. per gallon placed in the fuel tanks of the motors, as compared with about four times that cost for kerosene and more yet for naphtha or gasoline.

All the machinery used had to be made here at the factory or adapted from other tools in use on the place, some of the resultant implements being a combination of three or four distinct tools of various makes. Descriptions of these will be given further on and an idea of the construction of some of them can be obtained from the accompanying plates.

We selected the Fordson tractor for these trials, and, as a result of these, have definitely adopted it because of its cheapness, lightness, simplicity and ease of securing spare parts—these considerations after the discovery that the motor works perfectly on denatured alcohol, even though the agents themselves were somewhat skeptical on this point when we began the experiments. They feared



The Planet No. 43 Machine from which was made the Furrower or "Middle Buster."

that the earliness and dryness of the alcohol explosion would cause deterioration in the cylinders, but a year's work under all sorts of conditions has failed to reveal any sign of such an effect in any of the six tractors we have in use at present.

The carburetors of these motors needed no change for alcohol, the motor being started on gasoline and the little pre-heating coil serving to put the alcohol in satisfactory condition for easy explosion in about two or three minutes. Naturally, with alcohol, less carbon is accumulated on the sparking plugs than with kerosene. It is advisable to run the last four or five minutes at night on gasoline, so as not to leave alcohol, which contains water, in the carburetor until work is renewed, as rusting of the pre-heating coil may be the result.

Breaking Out Middles—The usual manner of breaking out middles is to

run two furrows down the center with ordinary 8-in. or 9-in. share plows. The author's desire was to break out the middles with one operation, and the first trials were made with a 14-in. furrower with a man behind. This immediately proved impracticable, as no man could keep up with the plow all day with the motor developing efficient speed. We then adapted a furrower to a Planet No. 43 cultivator body, and also to the Avery-Magnolia cultivator body, arranging the raising and lowering devices so that they worked satisfactorily with the double moldboard plows, thus converting our furrowers into riding

Off-barring Cane with a Tractor.

plows, until we can obtain a plow coupled direct to the tractor which will need no plowman for its attention, thus economizing one man's salary on the day's work.

The next difficulty with this implement was that it threw too much dirt to the rows and destroyed traction and depth of entry for the off-barring machine which followed it. This difficulty was finally met by removing the "wings" of the shares, when we found that we obtained just as good work without so much movement of the dirt to the rows.

With the furrower in its present shape, we can break out the middles of about ten acres of cane daily.

Off-Barring—For this work we utilized and strengthened the Deere disc-bedder, as shown in the illustrations. This work is usually accomplished by running a furrow close up to each side of the row with a share plow, but with this machine we do the work far better in one operation. This is really the prettiest work we have done with the tractors, the photograph evidencing its efficiency. The rows are smoothly and deeply off-barred, any projecting stubble cleanly pruned off and the dirt beautifully pulverized and thrown well to the

Cane Off-barred with Tractors. These Machines worked a half-mile without turning.

centers, leaving ideal conditions for the stubble shaver, which requires neat off-barring and the dirt well thrown away from the rows for full efficiency.

With this off-barring machine we cover eleven to twelve acres daily.

Shaving and Digging Stubble—For this work we combined the Avery stubble shaver and the stubble digger into one machine by taking off one pair of wheels of the shaver and connecting the two by a rigid plate. This is the quickest work which we do with the tractors and it saves the expensive spade or hoe

work of knocking the dirt off and from around the stools and returning the same dirt afterwards. It leaves the stools cut cleanly off and well down into healthy cane, lowers the rows for easier irrigation and subsequent cultivation and leaves an ideally soft mulch over the tops of the stubbles, conducive to quick and easy germination. The whole secret of success with this machine, which so many people seem to have ignored, is the keeping of the horizontal discs well sharpened and properly adjusted. We send a Little Luther grinder into the field with each machine and the discs can thus be easily and quickly removed and filed in about ten minutes after about two acres of work. By having extra discs with each machine, the only time lost is that required to unscrew and screw

The Disc Bedder arranged for off-barring with Tractors.

up again a couple of nuts for removing and replacing the discs, the discs taken out being sharpened by a boy while the machine is running, or after working hours at midday and evening by the tractor operator himself, for a few cents per disc.

With this machine fifteen acres of cane can be covered in a day, with rows at 6 ft. 6 in., as we have them here at Tucuman for the rapidly suckering Java canes. Naturally with 5 ft. rows, such as are commonly employed in Louisiana, Hawaii and many other countries, a proportionately smaller acreage must be calculated.

Miscellaneous Work—We have used the tractors, also, for throwing dirt to the cane by running the disc bedders down the centers, and for weeding by pulling a pair of reversible disc harrows, parallel and in two middles when the cane is still low enough for the motor to straddle the row, and tandem and in

Cutting and Shaving Stubble at One Operation.

one middle at a later time. For pulling ordinary road machines of the "Champion" type, they serve admirably, as well as for large plank drags, clod-breaking rollers, smoothing rollers and the like. In the coming cultivation season we expect to try them out for other operations of later cultivation.

Running Expenses—We have found it the best policy to have one good man in charge of all motors and give him good transportation facilities, such as a motor cycle or light motor car, thus enabling him, even on a very large place, to see all of the machines several times per day. The driving can be done by boys quickly broken into the work. These can start the motors and manage them, change sparking plugs, tremblers, etc., and see to the requisite supplies of water, oil, gasoline for starting and finishing, and alcohol, but any major trouble must await the coming of the man in charge. Such boys can be selected on any plantation from the brightest, more ambitious workers, and their salaries need be but little higher than the ordinary plowman's. Almost any boy would prefer to sit and drive a motor than to walk behind a pair of mules or bullocks.

Prices of materials vary so much in distinct countries that the author will not here attempt to calculate the cost of the work, which can easily be done by anyone interested by inserting the cost of alcohol, lubricating oil, etc., in his particular locality in the following table of daily consumption per tractor. These figures are for a day of eight hours' actual work, and include allowances for going to and coming from work at an average distance of three-quarters of a mile from where the motors are kept, the estimated quantities of materials used being, therefore, well on the liberal side. The amount of work done will be found under each operation already discussed—in number of acres covered per day.

Daily Fuel and Oil Consumption.

Denatured alcohol	80	litres	Cylinder oil	4	litres
Gasoline or naphtha	0.5	"	Marine oil	0.1	"

[J. A. V.]

The Loss of Fertilizers From the Soil.*

Professor J. Hendrick, B.Sc., of the University of Aberdeen, in a paper on "An Improved Scheme for Determining Unexhausted Manurial Values," which appeared in the Transactions of the Highland and Agricultural Society of Scotland, discusses the factors which influence the permanence of artificial and other fertilizers in the soil, with a view to the more accurate computation of the enhanced value of well-farmed lands. The following notes are abstracted from that portion of his paper dealing with the direct residues of fertilizers.

Nitrogen Compounds.

The case of nitrogen is the most difficult and complex, since it is removed from the soil *(a)* by crops, *(b)* by the drainage, *(c)* by escape into the air as gas through the decomposition of nitrogenous materials.

All the quick-acting nitrogenous manures are readily removed from the soil, and if not taken up by the crop are practically all lost from the soil by other means in the first year. They therefore leave no direct residue in the soil after the season of application. Nitrogenous manures which leave no direct residue after the first season are nitrate of soda, nitrate of lime, sulphate of ammonia, and nitrolim, together with the ammoniacal part of the dung and liquid manure of the farm. With these we may class dried blood and the nitrogenous part of Peruvian guano. Even in the case of manures made from the flesh of animals, such as meat-meal and the part of fish-guano which is not composed of bone, there is probably little residue left in the soil after the first season, and none after the second season.

On the other hand, slowly decomposing nitrogenous matters, like bone, hair, horn, and hoof, and the insoluble part of farmyard manure, which consists largely of straw, are only exhausted from the soil over a period of years.

Phosphate Manures.

The case of phosphates is quite different from that of nitrogen. Practically no phosphate is lost in the drainage, and it does not escape as a gas. Even when applied as soluble phosphate it is all retained by the surface soil. The only phosphate, therefore, which the soil loses is that removed by the crops. In the case of average crops of cereals, hay, and turnips, about 20 pounds of phosphoric acid, equal to about 44 pounds of tribasic phosphate of lime, is removed per acre per annum. This is equal to about as much phosphate as is contained in 1 cwt. of high-grade superphosphate, 38 per cent soluble phosphate, or in 1 cwt. basic slag, 40 per cent total phosphate. The equivalent of these, therefore, is removed from the soil per acre per annum by an ordinary crop.

Further, when soluble phosphate is applied to the soil it is quickly turned

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* From "The American Fertilizer," Vol. 54, No. 10, in turn reprinted from "The Chemical Trade Journal and Trade Engineer," London.

into a state insoluble in water, but, like the greater part of the phosphate in basic slag or steamed bone-flour, remains soluble in dilute citric acid. This is what is usually referred to as "citric soluble phosphate."

It is sometimes held that "soluble" phosphate which has been applied to the soil gradually reverts to a state of still greater insolubility than is represented by "citric soluble phosphate," and so becomes gradually less available to plants, till in time it becomes almost worthless. There is no proof that this is the case. Such evidence as we possess is all the other way, and indicates that even after several years practically the whole of the soluble phosphate which has been applied to the soil, and has not been removed by crops, can be recovered from the soil as citric soluble phosphate. When, therefore, a soluble phosphate, such as superphosphate, has been applied to the soil, any residue which it may have left should be valued at the cost of citric soluble phosphate, such as that in basic slag or steamed bone-flour, and not at the cost of water soluble phosphate.

In order to test how far phosphates and other manurial substances are lost from the soil when large quantities are supplied in soluble form, drainage experiments were made in tanks filled with soil from Craibstone, the experimental farm of the North of Scotland College of Agriculture. The soil is composed of partially weathered glacial detritus, and is free working and open in texture. The tanks were four in number, each 20 inches deep. They were protected from rain, and the water applied to them was distilled water, which was sprayed upon them in carefully measured quantity. Tank No. I was unmanured. No. II received sulphate of ammonia at the rate of 45 cwt. per acre. No. III received sulphate of ammonia at the rate of 40 cwt. per acre, and superphosphate (30 per cent soluble) at the rate of 90 cwt. per acre. No IV received sulphate of ammonia at the rate of 40 cwt. per acre, superphosphate at the rate of 80 cwt. per acre, and muriate of potash at the rate of 45 cwt. per acre.

The manures were not all supplied at once, but were mixed into surface soil in increasing quantities at intervals of a few months. The total amount of water sprayed upon the surface of the tanks during the period of the experiments, which lasted two years, was equal to a rainfall of about 115 inches, and of this there was recovered as drainage from each tank about 93 inches. The remainder was lost by evaporation. The surface soil was stirred up to a depth of two or three inches from time to time, to prevent it becoming consolidated by the water which was sprinkled upon it.

The following table gives a summary of the results of these experiments:

CRAIBSTONE DRAINAGE EXPERIMENT.

Drainage Tank Manuring	I. Nothing	II. Sulphate of Ammonia	III. Sulphate of Ammonia Super-phosphate	IV. Sulphate of Ammonia Super-phosphate Muriate of Potash
Nitrogen applied as ammonia....	0	1,068¼	949¾	949¾
Nitrogen in drainage as nitrate.	449½	1,611½	1,472	1,556
Phosphoric acid applied.........	0	0	1,512½	1,352¼
Phosphoric acid in drainage.....	4½	3½	3	3¾
Potash applied	0	0	0	2,447¾
Potash in drainage..............	44½	66½	74¾	1,163
Lime applied	0	0	2,868	2,572
Lime in drainage................	981	3,857	5,388½	5,882½

The figures given in the table show that when nitrogen was applied as sulphate of ammonia to Tanks II, III, and IV in the excessive quantities used in these experiments, it was all recovered in the drainage in the form of nitrate. Practically no ammonia was washed through, even when in the last stage of the experiments sulphate of ammonia was applied in a single dressing at the rate of 20 cwt. per acre to each tank. Though the soil was acid in reaction and had already lost a very large quantity of lime, nitrification was practically complete; and while the ammonia was retained by the soil and appeared in the drainage only in traces, in a short time it underwent a complete change into nitrate, and was washed out in the drainage in that form.

Potash Fertilizers.

The case of potash is somewhat similar to that of phosphates, but is rather more complicated. While practically no phosphate is lost in the drainage, the loss of potash is quite appreciable, and varies considerably with the conditions.

At Rothamsted the annual loss of potash from the surface soil through drainage is stated by Hall to be 10 pounds per acre. At Craibstone three drain gauges, each 1/1000 acre in area, have been built. In 1919 complete records of the drainage and drainage losses were obtained with these for the first time. The soil was unmanured, but grew a crop of oats. The rainfall was 34¾ inches, and the drainage about 25 inches. The loss of potash in the drainage was at the rate of about 22 pounds per acre.

In the drainage experiment summarized in the table, one of the tanks was manured with heavy dressings of muriate of potash, which amounted in the aggregate to 45 cwt. per acre, and great quantities of potash were lost in the drainage from this tank. Tangs I, II, and III received no potash manure, and the amount of potash washed out of them was comparatively small, though the soil is naturally rich in potash. The amount of potash in the drainage of these tanks is small, but it is very much greater than the amount of phosphoric acid washed out of the same tanks; and it increases in amount in Tanks II and III, to which manures were applied.

The case of potash, therefore, is quite different from that of phosphate, which was completely fixed in the soil, even when applied to Tank IV in the heavy dressing just stated. It also differs from the case of ammonia, for the ammonia does not appear as such in the drainage, even under these abnormal conditions, but undergoes almost complete nitrification, and is washed out as nitrate. No doubt the formation of large amounts of nitric acid helped to remove the potash from Tank IV. We may conclude, then, that a certain amount of potash will be washed from the soil in drainage, in addition to that which is removed by crops. The amount so removed will vary considerably according to the conditions; and though the conditions of Tank IV are not likely to be equalled in practice, potash will probably be more readily lost from sour soils, badly supplied with available lime, than from others. It is probable, too, that the loss will be greater in wet climates, where much drainage passes through the soil, than in climates where the amount of drainage passing through the soil is smaller, though the evidence on this point is slight, and direct drainage experiments in wet climates are needed.

The above considerations indicate in general that where ordinary dressings of soluble potash manures—such as kainit, muriate of potash, potash manure salts, and sulphate of potash—are used, or where potash is applied in customary quantities in the form of mixed manures like turnip manures, potato manures, or grain manures, most of the potash is removed by the crop or lost in the drainage in the first season, and little unexhausted residue is left.

Lime.

The results of various experiments, and especially of drainage experiments, show that the available lime of the soil is lost mainly in the drainage, and that any loss which takes place through the removal of crops is trifling in comparison with the drainage loss. It has also been demonstrated that the nature of the manuring has an important bearing on the loss of lime. The use of sulphate of ammonia, soluble phosphates, and soluble potash manures increases the wastage of available lime; while, on the other hand, nitrate of soda diminishes this wastage; and nitrate of lime, nitrolin (cyanamid), basic slag, bones, and ground-mineral phosphates add some available lime to the soil, and so help to compensate for the wastage.

The period which elapses before a dressing of lime is exhausted from the soil depends mainly upon the quantity of lime used. This is well illustrated in the Rothamsted and Woburn experiments, which supply the best available data on the subject. The famous Broadbalk field at Rothamsted supplies a classical example of the long period which is required for the exhaustion of a very heavy dressing of lime. The continuous wheat and barley experiments at Woburn, on the other hand, supply valuable evidence of the rate of exhaustion of smaller dressings. It is very desirable that drainage experiments should be made under different conditions of soil, climate, and manuring, in order to obtain direct and accurate information as to the actual losses of lime from the soil. At present we are forced to draw conclusions from very scanty and somewhat abnormal data which do not represent more than a small portion of the

conditions which actually occur in practice. Such information as we have, however, shows that practically all the loss of lime from the soil takes place through drainage. Any loss which occurs through the removal of crops is in comparison trifling. The drainage loss exhausts the lime of the soil continuously, whether a crop is grown or not, and whether the soil is manured or not. Even in the case of unmanured and unlimed soil there is a considerable loss of lime, which increases to some extent with the amount of rainfall and drainage, and with the amount of available lime in the soil. When the land is intensively farmed and manures are added, the loss of lime is increased, especially when ammonia compounds are used. Probably the loss of lime is increased by the use of farmyard manure also, but there is little evidence on this point. [J. A. V.]

SUGAR PRICES FOR THE MONTH

Ended June 15, 1921.

	96° Centrifugals		Beets	
	Per Lb.	Per Ton.	Per. Lb.	Per Ton.
May 16, 1921	5.13c	$102.60	No quotation	
" 17	5.12	102.40		
" 18	5.01	100.20		
" 19	5.02	100.40		
" 25	5.06	101.20		
June 1	4.985	99.70		
" 2	4.84	96.80		
" 3	4.63	92.60		
" 7	4.50	90.00		
" 9	4.25	85.00		
" 14	4.00	80.00		